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THE DUTCH EAST INDIES.

THE rapid development within recent years of the agricultural industries of the Dutch East Indies has attracted much attention and has been watched with much interest by all those associated with agricultural progress in the tropics. The Dutch have become such recognised authorities on certain lines of tropical agricultural research and on the production of tropical crops that several British Colonies have found it both profitable and necessary, from time to time, to have the Dutch methods closely studied by their agricultural experts. Those who have had the privilege of touring the Dutch East Indies have never failed to be impressed by what they had seen and learnt from their visits. Mr. Ormsby-Gore, as one of the last British representatives to tour Java, praises like many others, the soundness of the Dutch administration and the progress made in both their estate and native agricultural industries.

Of all the Dutch East Indies, which represent an area equal to half the size of Europe, Java is the only island which has been fully developed, and the prosperity which it now enjoys represents yet another triumph in colonial development. A little smaller than England, Java not only supports a population of thirty-eight million souls but ranks as one of the leading exporting countries of the world. Its presents economic position is due exclusively to the efficient way in which its agricultural resources have been exploited. Equal shares of Dutch, British and other foreign capital have helped to do this but full use has also been made of the most up-to-date scientific principles and machinery to develop the raw material available, and the natural advantages which the colony enjoys. The results obtained have been surprising and Java has now, in many things, to be reckoned as a leading contributor to the world markets. It is already second to Cuba as a sugar producer and it is the third largest tea exporter. The Dutch East Indies of which Java is by far the largest producer, supply just over a third of the world's rubber and hold nearly a complete world monopoly of the quinine, kapoc and pepper industries and export about two-thirds of the world's sisal crop. In addition to its exports Java grows nearly all the rice necessary to feed its large population, supplementing this main food crop by producing varying quantities of maize, cassava, ground-nuts, coffee, cocoa and tobacco. Finally, favoured by important differences in the climate of its lowlands,

hills and mountainous districts, it can also produce spices, European vegetables, flowers and numerous forest products. In short, it surpasses all other tropical countries in the variety of its vegetation and agriculture.

There are two distinct types of agriculture followed, the native and the estate. While the former is essentially bound up, except in the case of native rubber, with the production of an adequate food supply, the latter's chief object is the growing of crops for export. Both types of agriculture have been thoroughly organised and their prosperity is undoubtedly due to the efficiency and smooth running of private and Government research and educational schemes.

In no tropical country has it yet been possible to obtain a perfect connection between the planter and the research worker, and the methods employed for attaining this object are liable to considerable variations. Where a primitive system of agriculture is followed and where the plantocracy is illiterate, most of the investigational work is done by the Government. "In more advanced countries the tendency has been for work which relates to peasant crops to be carried out by the Government while that which relates to plantation crops is being placed more and more into the hands of special technical assistants who may be employed by the Government or the planting community." In the still more advanced countries, estate interests and companies finance their own technical specialists and research stations and the Governments are left mainly with the task of improving native agriculture. In this respect, the Dutch methods are exceptionally advanced. For instance, the scope of their Agricultural Department's work in Java is extremely wide. Forming part of what is known as the Department of Agriculture, Commerce and Industry, it functions both as an experimental and administrative body. Its experimental section comprises a botanical garden, a general agricultural experiment station, veterinary and forestry stations and a phytopathological laboratory. The information gained by these experimental stations is distributed through their administrative services. Besides the Government Department there are two other types of research organisations, of which one is devoted to research in special crops and is supported by syndicates of planters, and the other, which is also devoted to scientific research is financed by individual companies. Amongst examples of the former there are the two Sugar Experiment Stations at Pasoereean and Cheribon, the Tea and Rubber Research Institutes at Buitenzorg and the Coffee Research Station at Malang in East Java. Among the latter may be mentioned the work of the research division of the staff of the Boeneot Rubber Estate and the work of improving the yields of Oil palms and Hevea rubber by the Société Financière Belge.

Pasoereean affords an interesting example of Dutch investigational methods. Entirely supported by private sugar companies, the station is managed by a Director and a Board composed of representatives from the larger companies. The agricultural, engineering and chemical aspects of sugar production are studied in three separate divisions, the aim of the research work as a whole being to find optimal conditions in sugar production from the time the cane is in the soil to the time it is exported as sugar. Research is aided by the fact that sugar growing is confined in one district in the island and that as all cane is exclusively planted by the factory interests, experimental work can also be effectively controlled. Again, Pasoereean is connected to groups of factories by fifteen advisers, each of whom resides in the centre of a group of ten to twenty factories. Besides general advisory work and the supervision of field trials these advisers fulfill the functions of spreading the knowledge gained at the central station amongst the managers and overseers and of collecting problems submitted by the planters which are eventually distributed for special study at the central station. Every factory has also the right to call for expert advice from the central station whenever this is necessary. In this way the research staff and the plantation interests are kept in close touch with one another and investigation constantly stimulated.

The present review can be but a very cursory one of the economic development of the Dutch East Indies and of Dutch research methods. It is sufficient to show, however, that the prosperity of these colonies has been largely due to the educational facilities which have been generously provided by private and Government enterprises. It is fortunate that a great number of the numerous Dutch publications contain English summaries which have undoubtedly been greatly appreciated by those of our own research workers who are studying the same problems. It is only by exchanging ideas that progress can be achieved, and due credit must be given to the Dutch for expressing their opinions in a different language than their own and hope may tentatively be expressed here that they will increase the number of their translations. The thoroughness with which the Dutch have done their work, the steady continuous progress which they have achieved, the variety and wealth of their investigations all suggest that every encouragement should be given to our colonial servants to study what is being done and to learn, if necessary, some of the methods which have proved so successful in the Dutch East Indies.

According to the Secretary's annual report of the Queensland Cane Growers Association, Queensland's sugar production for 1927 amounted to 468,000 tons against a total Australian production of 491,500 tons. Queensland harvested 3,548,421 tons of cane, increasing its area under sugar by 22,450 acres. The average yield per acre worked out at 16.7 tons. The sugar exported amounted to 153,000 tons.

NURSERY WORK.

The Plant Nursery in the Tropics.

By R. O. Williams.
Superintendent, Royal Botanic Gardens, Trinidad.

General.

The principal function of a nursery is to raise and grow plants which are not sturdy enough to be planted directly into a garden or plantation, or which require skilled labour and special cultural care for their propagation. The plant nursery, as a necessary adjunct to most estates and gardens, is, for various reasons, normally a separate entity. The work is of a specialised nature, the nurseryman having to pay special attention to the selection and improvement of the plants he distributes. The nursery system is economically sound as it is cheaper to have young plants centralised in large quantities than scattered in their permanent positions in the field. From the planter's point of view it is generally more advantageous for him to buy good types of plants from public or trade nurseries than to grow them himself.

Types of Nurseries.

The following types of nurseries exist :—

(*a*) Trade nurseries where a wide variety of plants are raised and sold for profit.

(*b*) Government controlled nurseries, as in the case of the Botanic Gardens, where plants are distributed free, or sold at a nominal price.

(*c*) Estate nurseries where supplies of young plants are raised for extension work.

In the West Indies nursery work is largely confined to the Botanic Gardens, but the term nursery is also often applied to beds or boxes in which flower and vegetable seedlings are grown for garden use.

Tropical Conditions.

Budding and grafting are the chief methods of vegetative propagation used in nurseries. In temperate countries and with temperate crop plants these methods assume various forms, but the nurseryman's work is in all cases based on certain well laid down principles. The nurseries are often owned by old established firms whose methods of plant production and reproduction rest largely upon the results of years of scientific and practical investigation, and are carried out with the help of highly skilled labour. There is, no doubt, still room for improvement in many phases of their work, but generally speaking, their methods are all in a higher stage of evolution than in the tropics, where conditions are very different.

Nurserymen in the tropics are often handicapped by lack of knowledge as to what is actually required in the way of type or quality for nursery plants (*e.g.*: the best types of stocks or scions). Under the circumstances the best that can be done is to make use of methods which have been found suitable in temperate regions, and the plant nursery has to fulfil the additional function of an experimental station.

Plant nurseries in the tropics largely developed as part of the natural work of Botanic Gardens, and to separate their past records of work from that of the Botanic Gardens would be impossible, as both together may be regarded as having played a part in the introduction and distribution of many economic and other plants. They are in several cases more than 100 years old. Most of them were started by the local Governments and at the end of the nineteenth century, many of the West Indian nurseries were assisted for a time, by grants from the Imperial Department of Agriculture for the West Indies.

Many new plants such as nutmegs, cacao, mangos and citrus, were introduced to the Botanic Gardens, and were propagated and distributed either free of charge or at a nominal cost. Although some of these plants have now become of major economic importance and have been developed on a large scale—nursery work is still largely confined to them.

Prices for nursery stock were intentionally fixed at a low figure to encourage, as much as possible, the planting of good types of plants for the benefit of the colony as a whole. The late Mr. J. H. Hart, a former Superintendent of the Botanic Gardens, Trinidad, stated in his annual report for 1887 that "The Government do not make any profit on the plants sold. The prices charged for plants are looked upon as some return for labour expended and as an apportionment of taxation to those who take advantage of the gardens. All taxpayers have to pay alike, all support the gardens. If all taxpayers wanted plants in the same quantity it would be right to let them have them free, but as all do not take advantage of the opportunity those who do should be charged at a moderate rate, so as to equalize the taxation by making some return for the expenditure." This same argument may be applied with equal force to-day.

The policy of distributing plants at a nominal rate naturally debars private enterprise from competing in nursery work. At first sight this may not appear wise, but the argument favouring the continuation of Government controlled nurseries is the resources in plant material, experimental stations and staff at the disposal of most Departments of Agriculture. In small colonies like those of the West Indies it is also doubtful whether private enterprise could find an outlet for plants on a large enough scale and at sufficiently high prices to make them remunerative. Agricultural methods on the whole are not on a sufficiently intensive scale to make a plant of reasonable price attractive to the purchaser.

Nursery work in many of the islands is now proceeding on a larger scale than it has ever done in the past, but the need for further investigation into propagation and reproduction methods has increased with the knowledge gained from the wider distribution of plants. To-day investigational work and the rigid selection of tropical seedlings, stocks and scions, where the plant requirements are known, have been recommended.

An instance of the demand made upon a nursery may be illustrated by the sudden popularity in the eyes of the planting community of budded grapefruit and oranges, and the following table will show the distribution of these plants from the Trinidad nursery during the past 15 years. These were all sold at the nominal price of one shilling each :

Year.	*Plants.*
1914-1918	2,478
1919-1923	8,568
1924-1928	25,014

Cacao provides an interesting example of how investigation work has to proceed hand in hand with nursery practice and may well be regarded as showing the process of evolution in the work of plant propagation (1).

When these islands were first planted with cacao, selection of seed was not practised, and this is still the case to-day, where proprietors raise their own supply of plants, as not enough is known of the cacao crop to decide on what lines seed selection should be made.

In 1912 the first systematically organised counts of the yield of cacao trees were commenced at River Estate, Trinidad, and since that time much valuable data has been collected. After some years the conclusion was reached (2) that cacao trees can be grouped into heavy, medium and poor bearers and that generally speaking they maintain this characteristic year after year. Special manurial treatment does not fundamentally alter them. There was thus the probability that heavy yield was an hereditary character and the St. Clair nursery work was based on this hypothesis, no actual proof being available. Pods for propagation purposes were from that time taken only from trees with an average yield of not less than 100 pods per annum and of good type as regards bean character. Previously, and concurrently with this work, investigations into vegetative methods of propagating cacao, viz.: budding and grafting, were being conducted in several parts of the world with varying success. It was not however until 1912 that anything on an estate scale was attempted (3).

In 1914 an experiment was commenced at River Estate to test the theory that yield was an hereditary character. An analysis of these experiments was made by Harland in 1928, who stated, "A heavy bearing tree may transmit heavy yield to its budded offspring. On the other hand it may absolutely fail to transmit and may give rise to trees which are much worse than the average. There is no method of telling whether a tree will transmit heavy yield either to its budded or seedling offspring except by testing it" (4).

The obvious lines along which nursery work for cacao must now proceed so as to be based on these findings is to propagate only from clonal varieties which have proved to be good, heavy and uniform bearers in a similar manner to that recently suggested for rubber in the eastern tropics (5).

Further investigation may also show that it is advisable to pay more attention to work on these lines with regard to stocks (6).

Lay out of Nursery.

Site.—The nursery site should be within reasonable access of good roads or railways so that transport charges on plants may be cut down to a minimum. The land should be as level as possible, and the best available in the district with rich and deep soil to provide ample supplies for potting purposes. A good water supply is essential. A sufficient amount of space should be reserved for seedling beds, placing out of potted plants, nursery buildings such as glass houses, potting and packing sheds, stables, offices, &c., and there should also be sufficient room from which to draw soil for potting, make dumps for leaves for the preparation of leaf mould and land for growing certain stock trees such as citrus, avocados, mangos, &c., and for conducting small experiments. At St. Clair with an output of from 150,000 to 200,000 pot plants per annum 15 to 20 acres of land are utilised.

Wind and Sun Protection.—The actual nursery in which the pot plants are grown must be well protected from wind and for most young plants from sun, although there are some exceptions, limes being a notable example.

Wind protection can be supplied by hedges such as *Hibiscus*, Governor Plum, *Dracaena*, *Murraya*, Camphor, *Rhapis* palm, &c., and if the area is large, by intersecting it with additional hedges, overhead shade, and by suitable trees, the Saman being exceptionally good for this purpose. If Saman trees are not available *Gliricidia* will do and will quickly make a cover when planted as large posts. Artificial shade may be provided by bamboos or wood uprights and cross pieces on which are laid large pinnate palm leaves, such as *Maximiliana*. These allow sufficient light and rain in wet weather to filter between the dried leaflets for the use of the plants. Concrete posts and wire make, however, a more permanent structure.

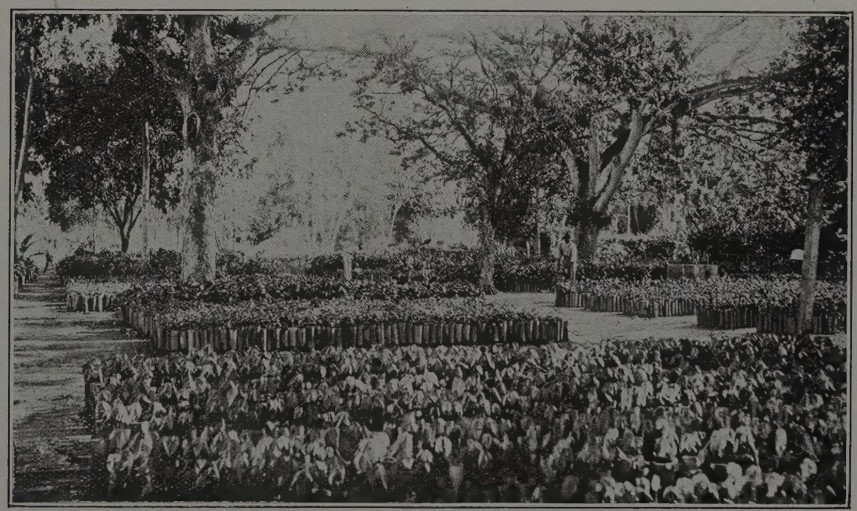
Shading is a necessity not only because many plants such as cacao and coffee need shade, but also because excessive evaporation from the pots is arrested, thus minimising work with the hose and waterpot. Too heavy shade produces weakly plants, which are highly susceptible to pests and diseases. As large quantities of water are used the nursery site must be thoroughly drained. Plants standing in stagnant water quickly suffer. If the soil is inclined to be sticky or heavy, it is best to spread two inches or so of coarse sand or fine gravel for the pots to stand on.

Greenhouse.—A glass house is a useful and almost necessary adjunct to any nursery in the tropics. Without its aid it is almost impossible to raise large quantities of delicate seedlings, or during heavy rains to bud avocados successfully. The simplest and lightest of structure is required. The common fault with glass houses is that

NURSERY WORK.

(*See* p. 35.)

Potting in bamboo joints—St. Clair Experimental Station, Trinidad

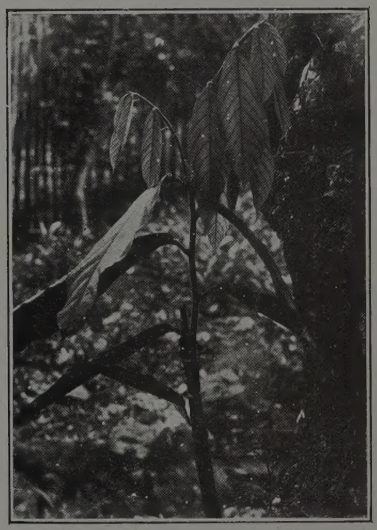


Cacao Nursery—St. Clair Experimental Station, Trinidad.

NURSERY WORK.

Budded Cacao Tree, 4 years old.

Old Citrus Tree, top worked with Homossasa Orange.



Budded Cacao Chupon, note trunk on right.

Budded Avocado.

they are so constructed that the seedlings become weakly and drawn from lack of sufficient light. All that is necessary is a structure with a glazed roof and open sides, with stages erected as near the roof as is practicable. Light shading can be supplied upon the glass by thin canvas blinds on rollers which may be dropped during the heat of the day or by spraying the glass with a mixture of lime and size.

Provision should also be made for isolating by water or oil certain stages upon which fine seeds, liable to the destructive agencies of stinging ants may be germinated. A good type of structure would be one built in the form of a cacao drying house, *i.e.*: with a sliding but glazed roof, which may be pushed over the seedlings during heavy showers.

Materials.

Soil for Potting Purposes.—This is prepared as follows:—Good fibrous turfy loam cut to a depth of five or six inches, is taken from an old pasture, and stacked neatly under cover, grass side down. When stacking, the turf is built up in layers, every two layers being supplied with good cow manure, or rotten leaves. Such a stack is left to condition for about six months and when required, is chopped straight down at the sides so that soil and manure will get well mixed.

Leaf Soil.—Many plants do better when leaf soil is added to the potting compost and some, such as ferns and begonias, require a high percentage of it. In the tropics good leaf soil is difficult to get and a dump into which all fallen leaves can be collected is necessary. This should be made in a moist, shady place where the leaves will decompose sufficiently in 9 to 12 months to be passed through a coarse sieve. In West Indian nurseries where use is made of leaf soil, young plants such as cacao and coffee are apt to suffer with chlorosis, (white leaf). At St. Clair Experiment Station, watering of the affected plants with sulphate of iron, 2½ oz. to 2 gallons of water, applied once a fortnight till the plants are fully recovered has given excellent results.

Sand and coarse gravel for mixing purposes will also be necessary to drain the pots.

Receptacles.—The clay pot is not used for general nursery work except for a few of the rarer plants; imported pots being too expensive on account of freight and breakage in transit, and locally made pots of too soft a material and also expensive.

In Trinidad freshly cut joints from the bamboo (*Bambusa vulgaris*) are the common receptacle. They are cut to an even length of about 10 inches and may be purchased for about $3.50 to $4.00 per thousand. The best sizes are those from joints 3½ inches to 5 inches in diameter although smaller ones are useful for some plants.

In Demerara, baskets are used. These are about five inches high by six inches across and are purchased at the rate of 1*d.* each.

Seed boxes about 16 inches long and 14 inches broad, may be conveniently and cheaply made from the 50 lb. potato crate, the top and bottom of which can be cut off to a depth of four inches.

Budding and Grafting Tape.—This is prepared by boiling together an equal quantity of bee's wax and ship's pitch and dipping ½ or ¾ inch tape in the mixture whilst it is still hot. The superfluous mixture may be removed by drawing the tape through a split stick. This is hung to dry until cool, and when slightly tacky is ready for use.

Propagation Methods.

Cacao.—Cacao is propagated principally from seed. Those grown in the St. Clair Nursery were selected for large and numerous beans, and are good Forastero types taken from parents with a known yield of more than 100 pods per annum. The pods are broken and the seeds rubbed in a little coconut fibre and soil to remove the mucilage and sown a few inches apart in well prepared nursery beds at a depth of about two inches. The beds are shaded by a pinnate palm leaf supported three feet above the soil on bamboo uprights and cross pieces. Germination takes from three weeks to a month. When the plants are about one foot high they are lifted and potted into bamboo joints about one foot long and three to four inches in diameter. These joints have a hole punched in the bottom which is covered with layers of coarse gravel, and potting soil (made up of prepared compost and leaves), and if necessary, sand. When the seedling is potted, care should be taken to see that the primary root is not curled, that the plant is not inserted too deeply, and that the soil is pressed firmly round up to about an inch off the top of the pot to allow room for watering. The plants will suffer from drought in dry weather if there is not that amount of room to supply sufficient water to soak the whole of the soil in the pot. After potting, the plants are spaced under the nursery shade in rows six inches apart in lots of 500, with alley ways between. They remain in these pots for six to eight months before they are despatched to the plantations.

The first vegetative method to be practised on any scale was grafting by approach, a method which was first recorded in Trinidad by Mr. J. H. Hart ([7]). In Dominica where similar work was also taken up by Mr. J. Jones ([8]), many plants were raised and experimental plots laid out. In neither island, however, did it assume commercial importance.

Grafting.—The method for grafting cacao is as follows:—

Stock plants preferably of the Calabacillo variety which is hardier than the Forastero are grown in bamboo pots until they are about eight

months old. These are then taken from the nursery and fixed in position against the branches of the mother tree by putting the pot in the top of a split bamboo pole inserted in the ground. If a large number of grafts are required and there are ample twigs for scions close together, a rough staging is erected on which to stand the bamboo pots. The seedlings, and the branches used as scions must be close enough together so that when they are united there will be no strain on the union. The stock is prepared by cutting off the head of the plant about 9 to 12 inches from the base, where the stem is brownish in colour and ⅜ to ½ inch in diameter. The cut is made obliquely and smoothly, with a surface 2½ to 3 inches long. A longitudinal cut of similar dimensions and tapering out gradually to the bark is made half way through the stem upon the scion. Both cut surfaces must fit exactly and be tied together with soft string just below the incision, which in turn must be completely covered with budding tape. For the operation to be successful the stock and scion should be as nearly as possible of the same size and maturity. In dry weather the stocks will need watering at least once if not twice a day. At the end of ten weeks the tape may be removed. If a union has been effected a notch is cut half way through the scion below the point of union. Two weeks later it may be severed completely, and neatly trimmed and tarred. After it has been kept in the nursery for two or three weeks, the plant is ready for its permanent place in the field.

The method used in Dominica by Mr. J. Jones was identical except that a similar cut was made in both stock and scion, and the head of the stock was not removed until a union was effected.

Budding.—The budding of cacao was successfully demonstrated on suckers of old trees in Jamaica by Mr. Harris in 1903 (9). In Trinidad the work dates from 1912 and has been confined, except for experimental work, to young stocks.

Budding is a much more economical method than grafting. Apart from saving additional labour in watering and expense in fixing stagings more economical use can be made of scions as information on heavy bearing is restricted to comparatively few trees.

The method is as follows :—

Stocks similar to those used for grafting should be selected. At 6 to 12 inches from the base of the stem a rectangular patch of bark is removed about ½ to 1 inch in length and about half the circumference of the stem. Plump and dormant buds should be selected from twigs of about the same size as the stock, as those from the top 12 o- 16 inches of the stem are unsuitable. Both the stock and twigs should be in vigorous growth, when the bark will lift easily. A piece of bark of similar shape to that taken from the stock and with a bud in the centre should be cut and placed immediately in position on the stock. This is then bound around with adhesive tape in such a manner as to leave the actual bud exposed. In two weeks the tape can be removed, to see whether the bud has taken, the point should then be pinched out of the stock and the plants set aside to allow the inserted bud to develop. When several inches of good strong growth have been made the stock should be cut back immediately above the point of union and the cut treated with crude oil.

This method of budding in bamboo pots is one adopted in the St. Clair nursery where the plants have to be transported a considerable distance before planting, but in estate nursery practice it is not necessary to raise the plants in bamboo pots. Nursery beds should be made as near as possible to the place where it is intended to establish the trees permanently and to bud the plants, as long transit may cause damage and curtail vigorous growth.

Coffee.—The usual method to propagate coffee is by seed. It is a common custom to take plants from under old trees which have dropped seed, germinated and grown more or less wild. This method is to be condemned as the plants may be the progeny of immature or diseased seed and are weakly in growth.

For nursery work the seeds should be selected from healthy good bearing trees of the required species or variety, the seed plot being isolated as far as possible from other varieties to avoid the possibility of intercrossing. The seeds which should be washed out of the cherries and sown in beds like cacao seedlings, or in boxes in a shady place, take five to six weeks to germinate. When about five or six leaves have formed they will be ready for potting into bamboo pots or for transplanting into other beds at a distance of about one foot apart. Potting and the treatment of the plant in the nursery is practically the same as for cacao. Coffee grows more slowly than cacao in its initial stages, taking from nine to 12 months from the time of sowing to the time when it is fit for planting in the field.

(*To be concluded.*)

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PEASANT DEVELOPMENT.

Co-operation and Peasant Development in the Tropics.

BY C. Y. SHEPHARD.

[*With acknowledgments to The Year Book of Agricultural Co-operation in the British Empire, 1929. Edited by the Horace Plunkett Foundation, Routledge*].

THE present century has witnessed a remarkable growth in the importance of the tropics to the temperate zones both as suppliers of raw materials and food, and as purchasers of manufactured articles. It is the accepted policy of the Mother Country to stimulate Imperial interdependence.

Since political or climatic considerations prohibit, or impede, European plantations in many of our tropical possessions, the expansion of this trade must largely depend upon peasant agriculture. The purpose of this paper is to discuss briefly and superficially, and without pretending to embrace all the peculiarities of the tropics, the manner in which co-operation can assist in solving this extraordinarily complicated problem. The greatest difficulty lies, not in doing, but in knowing what to do. Each area has its local problems and subtle differences in economic structure may necessitate an entirely different method of treatment. Thus recommendations based on analogy may prove extremely misleading.

Prior to the advent of the British, native agriculture was largely self-sufficing. The peasant produced all he consumed, and consumed all he produced, and his economic horizon was, and to a large extent is, limited to his immediate bodily needs. But when "cash" crops are introduced the position changes and the peasant is brought violently into world economics, which necessitate the modification of his whole economic environment. With the immediate need for preserving the local supply of food, the production of export crops must arise, either from the surplus labour released by more efficient methods of food production, or by the additional labour stimulated by increased wants. Interference with the traditionally accepted methods of cultivating indigenous food crops requires extreme caution, since the methods in use have been evolved through generations of bitter practical experience, and are, in some cases, far in advance of our existing scientific knowledge. Thus the Indian practice of "rāb," or firing a thick layer of vegetable matter on the rice fields before planting was condemned as a waste of humus but is now known to have a definite and beneficial effect on the bacterial flora of the soil. Some practices which appear to be the result of mere superstition have, did we but know it, a sound scientific basis. Others probably with a sound economic origin, have degenerated into mere inefficient excrescences. It is essential that the two should be carefully separated, for failure, consequent upon the ill informed modification of customary methods, is liable to prejudice the peasant against subsequent sound innovations.

The introduction of exotic 'cash' crops also requires careful judgment but, since the method of cultivation must be novel, it affords an easier opportunity for introducing progressive methods. Thus the introduction of cotton and ground-nuts into Uganda and Tanganyika is necessitating the use of ploughs and draught cattle. We must provide an incentive whereby this desire for improvement may be stimulated. The tropical peasant is an uneconomic individual, and we must, by education in its widest sense stimulate his economic desires, and by human and animal hygiene, sanitation, and medicine provide him with the ability to satisfy those desires. Lastly, by improved agricultural methods and equipment, transport and marketing facilities we must provide him with the opportunity. Could we but stimulate a desire for a better standard of living, coupled with the ability and the willingness to work for it, we should have solved, to a large extent, the immediate major problems of tropical development.

As one means of facilitating this movement, agricultural departments staffed by trained scientific and administrative officers, have been established in almost every colony. It is idle to imagine that the impetus of agricultural science could, in a single generation, overcome the inertia of centuries, but while progress has been rapid, it is desirable that we should investigate those factors which tend to retard it. Many scientific discoveries fail to be translated into general agricultural practice because either the peasant is unaware of such improvements, or is unwilling, or unable, to adopt them. The expansion in size of colonial agricultural departments which is now taking place, should eventually ensure that the discoveries are at least brought to the notice of the peasant in a manner which he is able to appreciate. In some cases it must be admitted that prejudice against innovations has been stimulated by the hasty and imperfect conclusions of scientists, which have failed to substantiate their claims in agricultural practice. Nevertheless, there remain many improvements in methods and equipment which, though their worth has been unmistakably demonstrated, have not been generally adopted.

Early investigators were impressed by the oft repeated assertion of the peasant that he could not obtain, when required, the money necessary for the adoption of the new method or equipment. Further enquiry revealed the peasant in a state of chronic indebtedness, subjected to a crushing rate of interest, and compelled to purchase all his requirements from, and to sell all his produce to, his creditor. It was found that the money-lender—shopkeeper—produce-dealer, dominated the economy of peasant agriculture.

It was concluded that the only impediment to the successful development of the peasant, was the extremely high rate of interest which ensured that, once in debt, the peasant remained always in debt. Co-operative credit societies, which had proved successful under varying conditions in Europe, were therefore introduced, in some cases with scant modification, into the tropics. Credit was made available to the peasant at, to him, a ridiculously low rate of interest, which, with the money productively employed, would have afforded a reasonable prospect of profit.

With the burden of high rates of interest removed, an era of rapid development was confidently anticipated. Yet it must be confessed that in many cases the only appreciable effect of the credit society was to lure the peasant still further into debt. Many enthusiasts had preached co-operation as a panacea for all the ills of the peasant without adequately appreciating the nature of those ills. The mistake was made of attempting to mould the peasant to suit the system instead of moulding the system to suit the peasant. Before attempting to introduce ameliorating measures, it is essential that we should first understand the existing mechanism, and discover where and why it functions inefficiently. We must, therefore, ascertain why, under what conditions, and to what extent, the peasant borrows. Briefly, we have to study the whole economic structure of peasant agriculture. Thus equipped, we are in a position to investigate possible modifications in the existing system, or to explore alternative machinery.

In more economically advanced communities, the main incentive to borrowing is the expectation of profit. In the tropics, the main incentive is necessity. By a rough comparison of the probable return from the application of the loan with the rate of interest at which he can borrow, the European can estimate whether it would be profitable for him to borrow. If the rate of interest is so high that the probability of profit is small, he merely abstains from borrowing. Since the tropical peasant borrows from necessity, the nice calculation of possible profit does not arise, nor is he in a position to refrain from borrowing if the rate of interest is high. The moneylender is able, in consequence, to exploit the necessity of the peasant.

Necessity is, however, an inadequate explanation of either the heavy indebtedness of the peasant or the high rate of interest. Religious and social customs demand extravagant expenditure for a wide variety of festivities. Since social prestige is influenced by lavish display on these occasions, each individual endeavours to outdo the others. In these circumstances, there is a tendency for loans to be limited neither by necessity nor by prudence, but merely by ability to borrow. As ability to borrow is largely determined by the security of the individual, it is frequently the case that the peasant with the greatest possessions is the one most heavily indebted. There is a tendency for those cultivating permanent crops (such as cacao and limes in St. Lucia) to be more heavily indebted than those producing annual crops (such as cotton and arrowroot in the neighbouring island of St. Vincent) on account of the greater security they can offer. Prosperity, which enhances the value of the peasant's possessions, is utilised not so much for liquidating old loans as for incurring new debts. Many peasants still have cause to lament the post war boom.

The advent of British administration, producing law and order, providing transport facilities, title to land, definite taxation, and other factors essential to prosperity, has, by enhancing the value of the peasants' possessions, been responsible also for an increase in indebtedness. In so far as the peasant is deliberately prepared to sacrifice his material for his spiritual welfare, he is entitled to our respect, but it is doubtful whether he fully appreciates the significance of this sacrifice. We find, then, the peasant deeply indebted, with his credit exhausted as the result of unproductive expenditure.

The peasant obtains his credit from the moneylender, who not infrequently combines with this calling, the functions of storekeeper and produce dealer. It is customary to describe the moneylender as an avaricious and parasitic individual who mercilessly exploits the improvidence, piety, or necessity, of the ignorant peasant. It is doubtful whether the moneylender is, by nature, more avaricious than any other class of individual, but, in any event, mere idle abuse will not assist us in improving the lot of the peasant. It is more profitable that we should attempt to analyse the circumstances which endow him with such powers. Were moneylending so profitable as is generally supposed, one would expect the field to be subjected to much greater competition. (1) Perhaps the profits are less than imagined, or possibly the moneylender secures high profits because he is more efficient, and therefore performs the service of lending more cheaply, than any alternative mechanism.

The realisable assets of the peasant are usually small, so that loans are frequently granted on personal security. Repayment depends upon the ability and willingness of the borrower. Illness or death among the peasant's family or his cattle, an outbreak of plant pests or diseases, inclement weather, low prices for his produce, or any one of numerous other factors, may affect the ability of a borrower willing to repay. Over the limited area covered by the individual moneylender, adverse factors may prevail and sometimes occasion extremely heavy losses. To recoup himself the moneylender legitimately charges a rate of interest higher than that for loans offering better security. Often the peasant borrows without the ability, or an attempt, to realise the nature of his obligations, and with no intention, if he can possibly avoid it, of repaying. This is

largely responsible for the viciousness of the system, the high rate of interest, and the harshness of the moneylender. Since many fail to repay on account of inability or unwillingness, the profits of the moneylender, although great, are not so high as the rate of interest would suggest.

By confining loans to a restricted area, usually a village, and embracing the functions of storekeeper and produce-dealer, the moneylender is brought into intimate contact with his customers. This enables him to assess, without special enquiry, the credit-worthiness of any individual. As a condition of the loan, the peasant is compelled to make all his purchases from, and to sell all his produce to, the moneylender. This affords not only a triple profit, but also a control over expenditure and a powerful instrument of recovery. The moneylender therefore has a triple motive for lending to a peasant who is not in a position to quarrel about details such as rates of interest, weight, quality, or prices. To such an amenable customer money is advanced freely, within certain limits, and without too many awkward questions as to the objects of the loan. Nor is complete repayment rigidly insisted upon. An individual free of debt is free of control, and as the moneylender cannot afford to lose so valuable a client, complete repayment is the thing he least desires. While the peasant pays his interest with reasonable regularity, and does not increase his debt too heavily, he suffers very little from the attentions of the moneylender.

The ordinary commercial bank, disinterested in the buying and selling of commodities, and divorced from the daily life of the peasant, would find the cost of an enquiry excessively high in relation to the sums involved. Personal security is not favoured by banks, and the peasant has but little else to offer. Moreover, the expense of supervision and recovery would be great. Banks cannot compete with the moneylender in supplying credit to individual peasants.

We may, therefore, draw the conclusions that the profits of the moneylender are popularly exaggerated, and that he renders his services at a cost which, although high, is less than that of any alternative commercial organisation. If we regard him as evil, we must, at least for the present, recognise him as a necessary evil, and we must seek, either, to confine his activities to useful channels, or, to discover some substitute. Legislation as a means of reformation must be rejected, since in spite of its many ingenious guises, it has invariably proved ineffective. The moneylender is the product of circumstances and it is to the alteration of these circumstances that we must direct our attention.

Our alternative mechanism should embrace the advantages, but reject the disadvantages, of the moneylender. Of the three main problems, credit, marketing, and purchase, credit is the most important and the most pressing, and must normally be solved before the remaining problems are approached, since the peasant cannot obtain credit unless he purchases his requirements from, and sells his produce to, the moneylender. Where these conditions do not obtain, the rates of interest may even be higher.

The main advantage of the moneylender over other purveyors of credit, lies in his intimate personal contact with his customers, which obviates the cost of special enquiry. A co-operative credit society composed of members of the same district or village, each intimately known to the others, would share this advantage. But if the society were to lend in the same manner as the moneylender, there would be little reason to expect that the rate of interest could be appreciably lower. A disadvantage of the moneylender's system lies in the fact that the industrious peasant who borrows for productive purposes is subjected to a rate of interest similar to that for unproductive loans. It is clear that if membership of the society were restricted to industrious peasants and loans to productive purposes, the losses would be diminished and the rate of interest could be lowered. This would afford the society a great advantage over the moneylender, who cannot afford to be so discriminating. The moneylender seeks to eliminate the effect of risk by taking a large number of risks, whereas the credit society should seek to avoid risk. The society can cater only for the few who are able and willing to restrict their personal expenditure within their income, and their loans to an improvement of their earning capacity. Any attempt to include the individual whose heavy indebtedness is due to indolence and extravagance, must inevitably end in disaster.

To the members, the society would have to be a complete substitute for the moneylender in meeting their legitimate and necessary requirements, otherwise they would have to have recourse to the moneylender. They would also have to resist, or meet from income or savings, the requirements of religious and social customs. For this and other purposes the society would encourage thrift. The peasants' savings, where they exist, frequently take the form of unproductive accumulations. Such methods were probably engendered by lack of security, and by the absence of facilities for profitable deposit, and influenced by the desire for personal adornment. Law and order have removed the necessity of hoarding, while the spread of Government Savings Banks offering good security and a moderate rate of interest, afford a profitable means of investment. The peasant can now choose between the satisfaction of personal adornment and the income from investment. The credit societies should encourage deposits by members who would have the satisfaction of knowing that the money was controlled by themselves and for themselves. Although the members would join the society primarily for the purpose of securing credit, it is assumed, as with the clients of a Bank, that all the members would

not want to borrow all the time. At certain periods of the year, particularly during the harvest period, the peasant may have a cash surplus over his immediate requirements and when good crops coincide with good prices this surplus may be large. Unless he is encouraged to save, and unless facilities for depositing the money are readily available, he will frequently spend it in lavish extravagance, with the result that he is shortly compelled to borrow. By depositing this money with the society, the members would not only diminish the need for borrowing, but would also supply some of the loan requirements. Deposits might also be attracted from non-members.

By the careful selection of members, the restriction of loans to productive purposes, and the encouragement of thrift, the security the members would be able to offer would be greatly improved. But, since it would consist largely of nebulous qualities such as honesty and industry, and not of readily realisable assets, the individual would still be divorced from the normal sources of credit. By undertaking unlimited liability, whereby each member would become individually responsible for all the debts of the society, the security would be still further increased, for if the members had been selected with the necessary care, it is unlikely that all would be unable or unwilling, at the same time, to meet their obligations. With this security, the society would be in a position to approach credit institutions for the necessary loans. Since the peasant has been taught to regard Government as a benevolently maternal being with untold wealth, he is traditionally inclined to regard this as a legitimate source of credit. Such tendencies should be firmly resisted and the principles of mutual self help should throughout be stressed. While the individual cannot approach a Bank, the society could, because of its greater security. In this way the individual peasants might, co-operatively organised, solve for themselves the problem of credit.

Credit is normally the foundation upon which other types of co-operation must be built and this accounts for the striking preponderance of credit societies in the tropics. With the members independent of the moneylender they would, both as producers and consumers, be in a position to take advantage of differential prices for which they could co-operatively be organised.

So many exceptions to this generalised account will immediately occur to anyone familiar with any tropical area that as a description of any particular area it is valueless. The most urgent requirement is the appointment of trained and competent officers, thoroughly versed in tropical conditions, who, unhampered by the insatiable appetite for paper results, can thoroughly investigate local conditions and demonstrate to the peasant the means whereby he can achieve his own salvation. Co-operation is a subject for the specialist and the cheerful effervescence of the enthusiastic amateur constitutes one of the greatest existing dangers to co-operation. A single failure may damn for generations the prospects of a system otherwise assured of success. Substantial progress will result only from years of unrelenting and usually unrecognised toil. We have discussed merely the approach to the problem, but the actual formation and working of the societies are matters requiring equal care. It is important, however, to realise that there should be a preliminary, and not a post mortem, enquiry. *Festina lente.*

Summary.

1. Credit exhaustion is one of the greatest hindrances to the development of the peasant agriculturist.
2. His indebtedness is the result of unproductive expenditure, and his whole economy is dominated by the moneylender.
3. Co-operative credit societies can, under some circumstances, and if properly modified to meet local conditions, afford the industrious peasant an opportunity for sound development.
4. Having solved the problem of credit the peasant is a free agent and can proceed with improved methods of purchase and sale.
5. At all stages the constant study of local factors by trained officers should be regarded as essential.

(1) In India the occupation of moneylending is largely restricted by the caste system.

COCONUT PALM.

ACCORDING to Mr. C. H. Knowles, Director of Agriculture, Gold Coast, the coconut palm is a crop of fair potential importance in the Gold Coast. Trials are being made with its cultivation on a fairly large scale (Western Province 295 acres, Central Province 296 acres, Eastern Province 150 acres), the plantations being set out by the Department of Agriculture. These plantations began to come into bearing during 1927 and yields were obtained of 300 nuts per acre. Information of this kind is urgently necessary, notably with reference to annual fluctuations of yields, and these fields are invaluable in this respect.

A careful analysis was made during the year of the yields of ten plots of a Ceylon variety and ten plots of a local variety of coconuts on one of the Experiment Stations. The figures range over a period of eight years of full bearing for each plot, the area under trial totalling 13 acres, and the yields varying from 228 to 2,095 nuts per acre in the case of the various plots. The individual yield of every palm (673 palms) has been recorded for eight years and the highest yielding palms have been marked as parents for breeding high yielding strains.

During the year, model copra dryers have been planned and one has been erected in the Western Province. Moisture and other factors affecting the quality of the copra are being investigated, but results are not yet complete.

A review of the common coconut pests occurring in the Colony has been made.—(*Bulletin of the Imperial Institute*, Vol. XXVI, No. 2, 1928.)

RAINFALL AND CROP CONDITIONS.

A Review of Rawson's evaluation of the Sugar Crop of Barbados from the Rainfall, 1847-1874.

By H. M. Leake, M.A., Sc.D., F.L.S.

I.—Introduction.

It would be difficult to over-estimate the economic advantages that would accrue from a reliable method for the determination of the effect of weather conditions on crops. The very complexity of that dependence, however, renders the problem of constructing such a method extremely difficult. Even if it be assumed that in any one unit of cultivation, such as an estate or an agricultural tract, a crop is uniformly distributed from year to year over a mosaic of soils and is subjected to a standard system of cultivation—the truth of which assumption would require to be checked in each particular case—and the influence of diversity of soils and of systems thus eliminated, there still remain the diverse climatological conditions of which temperature, light intensity and the humidity of the air and soil are the more important. Each of these will have its effect on the plant and, ultimately, as a summation of growth, on yield. In temperate climates the influence of all these conditions is reflected in plant growth as witnesses the seasonally controlled growth of plants on which are superimposed those minor changes in rate of growth arising from such subsidiary, because intermittent, influences as a prolonged spell of drought. In the tropics, and especially in those areas lying within a rains belt, temperature and light do not exercise the same dominating influence; seasonal differences are marked by the greater or less intensity of the rainfall or even, as in a monsoon tract, by the alternation of a dry and wet season. Under these conditions, and they are the conditions which apply to a vast area of the earth's surface, rainfall becomes the dominating influence and the problem is materially simplified.

But even in this restricted application to tropical rains tracts the economic importance of a reliable measure of the dependence of the crop on rainfall is enormous. The tropics are being opened up with great rapidity and the dependence of the world on tropical agricultural production increases yearly. To the dealer in tropical produce the perfection of such a method opens up the possibility of more accurate statistical information concerning such production; to the producer and estate manager it will, with the accumulation of data, open the way to the more certain application of agricultural methods. There is, however, another aspect of the matter. Different crops, and even different varieties of the same crop, react differently to like conditions of moisture. Ability to trace a definite relation between the crop and rainfall implies, therefore, ability to define a specific, or varietal, rainfall requirement for any particular species or variety. Once this knowledge of the limitations imposed by the plant has been acquired, it will be possible, from a study of the rainfall of any particular tract, to determine with some assurance the particular species, perhaps even the particular variety, best suited to these conditions, and it will be possible to determine with like assurance the best sowing season for the selected crop. The result must be a considerable saving in pioneer work.

Specific instances are, perhaps, more instructive than generalities and one may be given here. Within the past week the writer has been asked, and not for the first time, for suggestions as to the variety of cotton best suited for a particular tract. None but the vaguest answer is at present possible. Despite the vast number of varietal tests made in the many cotton growing districts, no co-ordinated effort has been made to correlate the results with the different climatic factors of the different localities and the results retain little more than a local interest. Were the records of results to include details of these climatic conditions and above all, for tropical crops, of humidity, during the period of growth together with the salient features of crop history such as, in the case of cotton, the flowering curve in relation to date of sowing, a knowledge of varietal behaviour would be obtained which would bear a general interest.

These are the possibilities which any reliable method opens up. For the present, in the generality of tropical agricultural practice, they remain possibilities which have in a few cases only been reduced to actualities. The door, however, appears to be open and sufficient has already been accomplished to justify optimism as to the result of future work.

The basis of a relation such as is here indicated lies in the physiological reaction of the plant to humidity and, ideally, the determination of that relation should be based on the direct measurement of those reactions during the various stages of growth. With the relationship so secured, the variations of the actual, from the calculated, values could be used with some assurance in evaluating the subsidiary economic forces. This, unfortunately is not possible; the difficulties in the way of collecting experimentally data adequate for statistical treatment under field conditions, where normally a single record only is obtainable in one year, are too great. It becomes necessary, therefore, to employ data which are not free from subsidiary economic influences to establish the method. In this there lies a risk, for it partakes of the nature of arguing in a circle. The degree of acceptance to be attributed to a method so founded must depend on the number of cases and on the variety of the conditions to which it is found to apply. The method here employed is based on four determinations; first, the unirrigated wheat area of the Cawnpore District, India, calculated from an evaluation of the total monsoon rainfall prior to sowing; second, the unirrigated cotton area of the Cawnpore District calculated from an evaluation of the early monsoon

rainfall; third, the yield of cotton on the Dhulia Farm in the Bombay Presidency, India, calculated from an evaluation of the total monsoon rainfall and, fourth, the yield of cane on a Barbadian sugar estate calculated from an evaluation of the rainfall of eighteen months. The range of conditions is wide and the results afford *prima facie* evidence of the soundness of the method employed. These determinations are detailed in the original paper (1) in which the method is described. To this paper and to a more popular account of the work (2) reference may be made, for a review of earlier work on the subject. To these a fifth determination is now added based on the report by Rawson issued in 1874 under the auspices of the Government of Barbados (3).

The essential difficulty underlying these studies has been the correct evaluation of the intermittence of rainfall. What, for instance, is the relative value of 10 inches of rain falling in one day when compared with an equal amount of 10 inches distributed in small amounts over a time interval of, say, one month? Clearly the latter distribution is more valuable but by how much, and by what unit can it be measured? In the former of the two papers to which reference has been made, a measure of the value of rainfall has been worked out and to it the name 'effective rainfall' has been applied. Further, the possibility of determining the specific, or varietal, rainfall requirement of any particular species or variety in terms of the 'effective rainfall' has been indicated. For the present purpose a brief definition of the term is all that is necessary.

The 'effective rainfall,' E, is a daily measure of the cumulative value of rainfall and is the actual rainfall of the preceding 24 hours to which is added a constant fraction, in the conditions dealt with of a rains tract in the tropics, $\frac{19}{20}$, of the effective rainfall of the previous day.

That is:—

$$E_n = r_n - k r_{n-1} - k^2 r_{n-2} - k^3 r_{n-3} - - - k^{n-1} r_1.$$
$$= r_n - k E_{n-1}$$

where r_n is the rainfall of the 24 hours ending on the morning of the nth day and k is, for any particular set of conditions, a constant, always less than 1 and here 19/20ths.

Of the four analyses referred to above as bearing on the question one concerns the cane production of a Barbadian estate. The conclusion drawn from that analysis was that the crop yield (tons of cane per acre) was dependent on the rainfall conditions of three periods, of which conditions the average daily effective rainfall was the best available measure. The correlation between the crop yield and the average daily effective rainfall of the three periods was found to be:—

(*a*) rainfall of the wet season prior to planting (June to December inclusive) $r = +0.44 \pm 0.14$.

(*b*) rainfall of the dry season following planting (December to May inclusive) $r = +0.42 \pm 0.14$.

(*c*) rainfall of wet season of growth (June to December inclusive) $r = +0.76 \pm 0.07$.

The coefficient of triple correlation derived from the above is $R = 0.76$.
and the regression equation,

$$X_1 = 4.12 + 0.026 X_2 + 0.055 X_3 + 0.540 X_4,$$

where

X_1 = yield of cane in tons per acre.

X_2 = average daily effective rainfall for the wet season prior to planting.

X_3 = average daily effective rainfall for the dry season following planting and

X_4 = average daily effective rainfall of the wet season of growth,

the effective rainfall being measured in units of 0.1 in.

The results are given in Table I. It will be seen that in one year, 1913, complete agreement is attained between the actual and calculated yields while the difference is, in nine cases less than 7.5 per cent., in three cases less than 15 per cent. and in two cases 20 per cent. or under. In only one year, 1921, a year of abnormally low rainfall during the wet season of growth, does the difference exceed 20 per cent. (32.2). In this case it is the low actual yield that gives emphasis to the percentage difference for the actual difference (4.9) is exceeded in the year 1919

TABLE I.

Year.	*Yield in tons per acre.*		*Difference.*	*Percentage difference.*
	Actual.	*Calculated.*		
1911	31.4	27.4	−4.0	−12.7
1912	23.5	27.0	+3.5	+14.9
1913	22.4	22.4	0.0	0.0
1914	24.3	25.6	+1.3	+5.3
1915	27.1	25.6	−1.5	−5.5
1916	34.2	32.7	−1.5	−4.4
1917	30.9	30.1	−0.8	−2.6
1918	25.0	30.0	+5.0	+20.0
1919	34.3	28.4	−5.9	−14.2
1920	23.2	24.9	+1.7	+7.3
1921	14.9	19.8	+4.9	+32.2
1922	25.1	20.9	−2.2	−16.7
1923	23.3	24.9	+1.7	+7.3
1924	20.5	21.6	+1.1	+5.4
1925	26.7	28.3	+1.6	+6.0
1926	26.0	25.4	−0.6	−2.3

when this difference was 5.9 tons. The conclusion may be summed up in less technical language. By the use of the effective rainfall it is found possible to estimate, at the end of December and, consequently, before the commencement of cutting the crop, the probable yield with an even chance of being within 3 tons of the actual.

(*To be concluded.*)

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AGRICULTURE IN MAURITIUS.

THE forecast of Sugar production issued in May, 1928, was 230,000 metric tons, a figure somewhat below normal, in spite of the favourable weather experienced during the growing season. Considerable reserve had to be expressed in view of the apparent deterioration of the white Tanna, the standard variety grown in the Colony.

To cope with conditions likely to be created by a breakdown of the Tanna, greater attention is being given to the locally raised seedlings and the contemplated extension of the cane breeding work is being materialised. A specially selected officer will also be sent to Coimbatore to study breeding experiments.

The local sugar market has been steadily declining and in view of the fact that the present quotations are the lowest since 1913, a material change in the grade of the sugar manufactured is envisaged and, possibly a greater proportion of lower grade sugars will be placed on the market in future.

Phytalus Smithi has been markedly in evidence, and, with present methods of control considerable funds are being absorbed on the campaign against the pest.

In view of the probable extension of irrigation work in Mauritius, an officer has been deputed to Hawaii where he will study the practical methods of irrigation.

The winter crop of tobacco has been, in many cases, a failure, as the variety selected (gold leaf) is unsuitable for the climatic conditions obtaining in Mauritius in winter. The first summer crop, however, promises well and a slight increase in the average grown is in evidence.

The market for fibre has improved markedly during the past four months and the total exported approximated to 1,000 tons.

EXPERIMENTAL ERROR.

A Survey of recent advances in Statistical Method.

(*Continued*).

BY E. J. MASKELL, M.A., PhD. (Cantab.)
Assistant Physiologist, Cotton Research Station, Trinidad.

The Effect of Season and Place.

IN drawing conclusions from such a series of experiments as that discussed in the previous section it will be noted that two types of conclusion are possible. (1) general conclusions valid for the whole range, (2) conclusions as to response in different years or places. Correspondingly there are two standard errors (1) that due to differential response of treatment or variety in different seasons or places (2) that due to soil variation. For a series of experiments in time we may call these *seasonal error* and *plot error*. The seasonal error includes the plot error and will usually be considerably greater. The general conclusions should of course be tested against the seasonal error, differences in particular seasons against the plot error. Suppose for example that the seasonal error of a *mean difference* between varieties is 10 units and the plot error 5 units; and that over the whole range variety *A* exceeds *B* by 24 units while *B* exceeds *C* by 12 units. Tested by the appropriate standard error (10 units) the difference between *A* and *B* is significant, while that between *B* and *C* is not. If we had used the plot error we should have concluded that both differences, *A-B* and *B-C* were significant, The apparent anomaly arises from the fact that significance or probability is always to be interpreted as probability in the light of certain information. When we use the seasonal error, we are testing whether, in the light of what we know as to the possibilities of different response in different seasons, *A* can be judged consistently superior to *B*. When we use the plot error we are asking only whether the average difference we observe is a genuine effect—not due, that is, to fertility differences between the plots. The average difference between *B* and *C*, although genuine, might be due to a chance combination of seasons favourable to *B* but not to *C*, and we cannot conclude that over a very large number of seasons *B* and *C* would shew any difference in yield. From the magnitude of the seasonal error (10 units) we might expect chance combinations of seasons favourable to one variety, to produce a difference of 12 units in 23 out of every 100 trials ($P=.23$). For the particular set of seasons in the case we have imagined, *B* is superior to *C*, but we could not predict superiority in another set of years. Similar considerations apply, of course when we are testing not varieties but manurial treatments.

In a recent discussion of the Principles and Practice of Yield Trials, Engledow and Yule [1] have drawn particular attention to the importance of this standard error, due to season, in variety testing. (Their equation for calculating the standard error differs in some respects from the

method considered in this paper but leads to essentially the same results.) They point out the desirability of obtaining, for any crop in which the plant breeder is interested, some estimate of this seasonal effect, as a guide (1) to the magnitude of varietal differences which will be worth following up (2) to the accuracy to be aimed at in replicating plots. Even for cereals sets of data giving the required information are very scarce; and work on this subject would be of great value. Engledow and Yule make also the important suggestion that it may be possible to shorten the time required for such investigations by making several sowings during the year, and so obtaining in one year more than one sample of weather conditions. It is to be hoped that this suggestion will be followed up, especially in tropical countries, where as is well known, time of sowing may have a profound effect on yield. One difficulty that may arise with certain crops, is that different times of sowing will involve different sets of length of day, as well as different sets of weather conditions, and it may not be possible to argue from behaviour over a range of sowing dates to behaviour over a range of years. This difficulty may be less important in the tropics, where the length of day varies less during the year, but there are, apparently, plants which respond even to the small difference in length of day between tropical winter and tropical summer. It is clear, however, that the suggestion opens up a very important field for research.

Such a study would necessitate a somewhat more complex type of experiment with a fairly large number of different plots. Essentially it involves combining two main questions, effect of variety, and effect of time of sowing, into one complex experiment. But as Fisher has pointed out ([2]), provided the *scheme* of the experiment is symmetrical, the analysis of such an experiment is quite simple and precise, and the general conclusions that emerge have the advantage of being based on a wide range of conditions. The symmetry required is merely an extension to the experimental scheme of that subdivision into equivalent blocks which is used for the field plan. Just as each block must contain one of each of the varieties (or treatments), so each time of sowing must be represented by an equal number of plots of each variety.

Combination of questions.

There has been a tendency in some quarters to insist that field experiments must necessarily be of a simple type, *i.e.*: that for each kind of question investigated a separate experiment must be carried out. Certainly complex experiments, unless they are symmetrically planned and correctly analysed, may give results which defy interpretation; but with the methods now available that difficulty need not arise.

As an illustration consider the types of quite practical question with which an experiment station working on the cotton crop may be concerned. These are—Varieties, Spacing, Time of Sowing, Time of Thinning, Manuring—(kind and quantity, also time of application)—Rotations, and, in irrigated regions, Water Duty. The current practice is to investigate each of these questions separately. This involves restricting each investigation to some particular combination of all the other factors which are known to affect yield. The results, however accurate, are accordingly of very limited applicability. For instance, there is probably some effect of Spacing, which is common to a number of varieties. But we should have no confidence in drawing conclusions as to this general effect of Spacing from results for one variety only. If, however, we combine the two questions, Variety and Spacing, into one experiment, we can determine that general effect with some accuracy, and obtain also considerable information as to the way in which Spacing and Variety interact. It will be seen that the newer statistical method, *i.e.*: the Analysis of Variance, with its distinction between main questions and differential effects, is admirably adapted for such experiments.

It is important to note also, that, even if we use no more land for the complex experiment than would be required for the two separate investigations, we determine the main questions not only over a wider background but with greater accuracy. Suppose for example we have four varieties A, B, C, D, and four spacings M, N, O, P, and 64 plots of land are available. Combining each variety with every spacing we have $4 \times 4 = 16$ treatments AM, AN, AO, AP, BM, BN, *&c.*, which will then be arranged at random in each of four blocks. If we investigate Spacing and Variety separately we compare the varieties at, say, spacing M and the spacings using, say, variety A. We take 32 plots for each experiment and so have eight replications for each treatment. Thus in the two separate experiments the effects of Spacing and of Variety are determined by comparing means of eight plots. In the complex experiment the general effects of Variety (independent of Spacing) and of Spacing (independent of Variety) are determined on means of 16 plots, *i.e.*: with twice the accuracy of the two separate experiments. Moreover, although in the complex experiment the effect of Spacing on variety A is determined with only half the accuracy (mean of four plots, instead of eight) attained in the simple experiment, we obtain also comparable information as to the effect of spacing on varieties B, C and D. The scheme of analysis of the complex experiment is set out below in two stages.

Stage 1.	*Degrees of Freedom.*	*Sum of Squares.*
Total Variation	63	$Sum\,(y \quad Y)^2$
Between 'Treatments'	15	$4 \times Sum\,(\bar{y} - Y)^2 = T$
Within 'Treatments'	48	$Sum\,(y - \bar{y})^2 = R^1$
Blocks ..	3	$16 \times Sum\,(y_B - Y)^2 = B$
Random plot variation ..	45	$R^1 - B = R$

This is treating the experiment as if it were a simple experiment with four blocks and 16 treatments. From R we obtain the field or plot error $\sqrt{R \div 45}$ for one plot or $\sqrt{R \div 45 \div 4}$ for means of four plots. The second stage of analysis deals with the variation between 'treatments.'

Stage 2.	*Degrees of Freedom.*	*Sum of Squares.*
Between 'Treatments'	15	$4 \times Sum(\bar{y} - Y)^2 = T$
Variety ..	3	$16 \times Sum(y_V - Y)^2 = V$
Spacing ..	3	$16 \times Sum(y_S - Y)^2 = S$
Interaction between Variety and Spacing ..	9	$T - (V + S) \quad = I$

The notation used is; y=yield of any plot, Y=mean yield of all plots, $\bar{y}$=mean for any treatment, y_B=mean for any block, y_V=mean yield for any variety, y_S=mean yield for any spacing.

The values obtained for V, S and I will shew at a glance the relative importance of the general effects of Variety and Spacing and the extent to which they interact. From the variation I, we can calculate the standard error, due to interaction, of the mean yield for any spacing or any variety. This is $\sqrt{I \div 9 \div 16}$, By comparing the mean differences between any two spacings with the plot error, $\sqrt{R \div 35 \div 16}$, we determine the existence of any average difference due to spacing; by using the standard error due to interaction, we can further determine whether the mean difference is consistent over the range of varieties used. Again, a comparison of the variance due to interaction, with that due to plot error will answer the general question whether there really is any differential response of different varieties.

It is clear that by judicious combination of questions in this way the investigator can cover a wide range of experience with the certainty that, if there are any generalisations possible about the effect of the factors he is investigating, those generalisations will stand out quite clearly from the results. The actual choice of questions to be combined must naturally be decided by the requirements of each investigator. A number of valuable groupings may be made for instance from the list of questions given earlier as typical of work at a cotton experiment station. The method is likely to be of greatest use in preliminary or survey work since it clearly exhibits the master-factors and the extent to which they are affected by interaction. In such work replication of the units might be reduced to a minimum of three or two plots. More than two types of questions might well be combined, but the number of treatments in each type of question would need to be kept low. For instance, three main questions each involving three 'treatments' would mean 27 combinations; four 'treatments' would mean 64 combinations.

A complex manurial experiment.

A comparatively simple case of combination of questions in a manurial experiment has recently been described and discussed by Eden and Fisher(8) As a guide to the principles involved and the analysis of results their full account should be consulted. A brief outline may be given here. The experiment concerned top dressing of oats with nitrogen and the questions combined were

(1) Kind of nitrogen: Muriate or Sulphate of Ammonia: M or S.

(2) Quantity of nitrogen: None, Single or Double dressing: 0, 1 or 2.

(3) Time of application: Early or Late: E or L.

Taking all possible combinations of the main factors there are $2 \times 3 \times 2 = 12$ treatments.

0 (M E)	0 (M L)	0 (S E)	0 (S L)
1 M E	1 M L	1 S E	1 S L
2 M E	2 M L	2 S E	2 S L

Four of the twelve treatments are identical (the no manure plots), since if no manure is given kind and time of application have no significance. All four plots were, however, retained so that, when general comparisons were made between the O, 1 and 2 dressings, the same number of plots should be available for each class. The experimental area had eight blocks, each containing the twelve treatments arranged at random. Although there were thus only eight replications, each of the main questions, *viz.*: Muriate versus Sulphate, Early versus Late, Single versus Double and None versus Single or Double, is determined with the accuracy attaching to the means of 32 plots. The same accuracy attaches, in this simple case, to the determination of the interaction between Time and Quantity, Time and Kind, Kind and Quantity of manuring. For the results obtained and the method of calculating the interaction the original paper should be consulted.

One other point of general interest in this experiment should be noted. One type of treatment, no manure, was repeated four times as often as the other treatments. The calculation of the standard error is accordingly of some interest. As pointed out by Engledow and Yule (1) a similar problem is likely to arise in variety testing, where the amount of seed available for new varieties may be much less than that available for the standard variety employed in the test. Fisher shews that if the principle of equalising the blocks is adhered to, *i.e.*: if the standard variety occurs the same number of times in each block, just as the others occur once in each block, the calculation of error can still be carried quite simply by the analysis of variance. The variation due to blocks may then be taken out in the usual way.

In calculating the variation due to treatment, we take first the means of the treatments that occurred once only in each block, sum the squares of their deviations from the general mean and multiply by the number of replications. Then, taking the mean for the treatment that occurred, as in the manurial experiment, four times in each block, we square its deviation from the general

mean and multiply by the total number of replications, in this case $4 \times 8 = 32$. Adding this to the sum of squares for the other treatments we obtain the total variation due to treatment. The remaining variation is plot variation and it consists of two parts, (1) random variation between differently treated plots, (2) variation between similarly treated (no manure) plots in the same block. The second part is easily calculated from the sets of four yields for the no manure plots in each block. The first part can be calculated by difference. In the case discussed by Eden and Fisher, comparison by the Z test of the two variances so calculated shewed no significant difference between them. Accordingly they were combined to give a general estimate of plot error. For a fuller account of the problem the original paper should be consulted.

Further development of the complex experiment.

It was noted earlier that, as the number of questions asked is increased, the number of treatments in a block rapidly increases and sets a limit to the possibility of combining questions. For the block then includes so many plots that field heterogeneity cannot be successfully eliminated. Fisher has devised one solution of this difficulty by applying the principle of deciding what are the main questions at issue and arranging that the experiment shall answer these, leaving the finer points of differential response to be included in experimental error. The main blocks in the field plan each contain all the combinations in the experiment; but each block is divided into *sub-blocks*, including some only of the combinations. Suppose we are investigating three types of question each with three units, *viz.*: A, B, C; a, b, c; and I, II, III. This gives $3 \times 3 \times 3 = 27$ combinations for each block. The 27 may be subdivided into three groups of nine. Each group will contain every combination of A, B, C with a, b, c; of A, B, C with I, II, III; and of a, b, c with I, II, III: thus one group of nine might be—

A I *a*	*A* II *c*	*A* III *b*
B I *c*	*B* II *b*	*B* III *a*
C I *b*	*C* II *a*	*C* III *c*

Consequently the interaction of any *two* factors at a time can be determined, leaving only the interaction of three factors at a time undecided. We have, therefore, three sub-blocks in each block for a more complete elimination of field heterogeneity. A discussion of this type of plan as applied to a manurial experiment will be found in the Rothamsted "Plans and Data" for 1926. As Fisher(2) remarks additional care should be taken in planning and reporting such experiments.

(*To be concluded.*)

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CUBAN SUGAR PROSPECTS.

ACCORDING to the *Economist* (Vol. CVII, No. 4,437) it is about a year ago since the President of Cuba despatched a representative to other large sugar-exporting countries with a view to bringing about a universal limitation of production. Although this official's mission failed, the President of Cuba signed a decree (21st January), against the advice of a small minority, confirming the recommendations of the National Sugar Defence Committee, fixing the Cuban sugar crop for 1927-28 at 4,000,000 tons. Of this, 3,300,000 tons were allotted to the United States of America; 150,000 tons reserved for home consumption and the balance for export to other countries. The attempt, however, to influence the sugar situation in the world was not to succeed, as Cuba, although the largest individual producer, can only claim to less than a fifth of the World's supply. The President has now consented to repeal the measure, the official explanation being that 82 per cent. of the Cuban sugar planters signed a petition requesting the discontinuance of restrictions on the coming season's sugar crop. It is believed that an unrestricted sugar crop in Cuba in 1929 may result in a glut of the commodity, and effect a serious breach in the situation of the market. A substantial carry-over of supplies in Cuba and the United States ports at the turn of the year was almost taken for granted. While statistical returns showed that the prospects of over-production and over-stocking during the current season were steadily receding, these, coupled with other indications, suggested an improving position for the commodity. Meanwhile, certain economies have been effected in the cost of production in Cuba, the results of which should be seen in the selling prices during the coming season. Earnest representations were made to the planters (*colonos*) to discontinue some of their wasteful methods of cultivation, and this—among other recommendations by members of the National Congress of Sugar Technologists, who have long considered the problems relating to Cuba's chief industry—having been attended to, substantial benefits for the industry may be looked for. Grinding will commence at the end of December next, and the season's output is estimated at not less than 5,000,000 tons. Last season's production, which ended in June, was 27,649,988 bags of 325 lb. each, resulting in an over-production of 80,758 bags, which went under the control of the National Sugar Commission.

CONTRIBUTIONS.

THE EDITOR is prepared to consider signed articles for publication in *Tropical Agriculture*. Such articles should normally vary between 1,000 to 6,000 words and may be illustrated if desired. Rates can be obtained on application to the Editor.

AMANI INSTITUTE.

By W. Nowell, D.I.C., F.L.S.

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The Amani Research Institute is situated towards the north-east corner of Tanganyika Territory, 5 degrees south of the Equator and 38 degrees east of Greenwich. This position lies in the eastern section of the Usambara Mountains, which rise abruptly from the level of the Pangani Valley on its northern side and are continued by the western Usambara and the Paré Mountains to the neighbourhood of Kilimanjaro. The buildings occupy the crown of a series of convergent ridges at a height of 3,000 feet and the cultivation extends down the slopes to a mountain stream of 1,300 feet and ascends a neighbouring summit to a height of 3,700 feet.

The region is one of heavy rain forest of the usual mixed tropical type and the ground flora is of the soft and luxuriant nature associated with shelter and high humidity. Maidenhair fern and balsams may be mentioned as characteristic plants.

The nearest port is Tanga, distance by road some 50 miles. For half this distance, to Muhesa, the Tanga-Moshi railway is available. The branch line marked on the maps is no longer working. There is a coast road connection *via* Tanga which enables Mombasa to be reached within 24 hours in favourable seasons. The main line railway previously mentioned connects through Moshi and Vio with the Kenya-Uganda railway system and its steamers on Lake Victoria. There is a dry weather road, very good for most of the way, between Korogwe on the northern line and Kilosa on the Central railway from Dar-es-Salaam to Lake Tanganyika. This road continues south through the Tanganyika highlands to the head of Lake Nyasa or through Abercorn on to Broken Hill on the Northern Rhodesian Railway. For more than half the year there is access to the south only by way of the sea.

The climate of Amani is illustrated graphically in the exhibited chart for 1926 prepared by Mr. C. B. Williams. The average rainfall is in the neighbourhood of 75 inches with recorded extremes of 55 and 95. The annual mean of atmospheric humidity is 86 mb., the annual mean temperature 67.8° F., the mean daily maximum 76.8 and minimum 63.7° F. The weather is for the most part cool and pleasant but with the prevalence of cloud and mist in the rainy season it is dark, not to say dismal, at times and for this reason a wood fire in the evenings is a comfort.

The area of the station is 750 acres, of which about a third remains under the original forest. A large part is occupied by permanent plantations. There are several small areas under Robusta and Arabica coffee and one in tea. There is a considerable area under Cinchona and there are plots of varying size of the different rubber trees, camphor, cinnamon, oil-palm, shade trees (Erythrina, Grevillea, Gliricidia), and numerous introduced timber trees including Eucalyptus spp. Cedrela spp., teak, and several of the tropical or sub-tropical Coniferae. There is a fine collection of bamboos, and a large and miscellaneous collection of trees yielding fruit or economic products of one sort or another. The collections of less durable plants have naturally for the most part disappeared. There is a large pasture in which *Paspalum dilatatum* from Brazil has been most successfully established.

Fortunately for the prospects of extended work at Amani there is now available, through the foresight of Mr. Ormsby Gore and the consideration shown by the Tanganyika Government, the large neighbouring estate of Kwamkoro, the former property of Prince Albrecht, which contains large clearings under Arabica coffee, a well-equipped factory, and considerable areas of level ground suitable for arable cultivation. Possession of this estate will give the Institute a large-scale contact with practical agriculture, which cannot fail to be valuable.

It was found necessary in German times and will be again, to establish sub-stations for work on the crops of lower and higher altitudes. Owing to the situation of Amani the levels with fully tropical conditions, in which such plants as coconuts, sisal, and cotton are grown, can be reached at no great distance, while the neighbourhood of Moshi and Arusha provides conditions representative of the inland plateaux. The contemplated sub-stations may be either temporary or permanent according to the purpose for which they are established.

The Biologisch-Landwirtschaftlichen Institut was established in 1902 by the Government of German East Africa. It was laid down in the original decree that the work of the Institute was to be directed to the practical needs of the colony. The Institute was not to concern itself with scientific studies which did not contribute to the maintenance and improvement of East African agriculture. That these instructions were not meant to be interpreted in a narrow sense is shown by the inclusion in the programme of work, after the list of more obvious duties, of the investigation of the fauna and flora of the country.

Dr. A. Zimmermann was the first (Acting) Director. Dr. F. Stuhlmann was Director-in-charge for three years from 1905, after which Dr. Zimmermann resumed charge and continued until the British occupation. A summary of the work of the Institute up to March 1914 may be found in *Beiheft zum Pflanzer*, Vol. X, No. 3. The permanent staff when developed appears to have consisted of two chemists, two botanists, and a zoologist, with the additional services of three other men of science for varying periods, and in addition a European laboratory, office,

and garden staff. The buildings were substantially constructed of stone and comprised a library, a botanical laboratory and herbarium, a zoological laboratory, a chemical building with a well-equipped industrial section, numerous sheds and workshops, eight staff residences, and some smaller houses for minor officers. There was also a hostel for the accommodation of visitors, a post and telegraph office, a dispensary, a school, and a considerable native village for the lab ourers.

The scientific work carried out at Amani during the German times is recorded in ten volumes of *Der Pflanzer* and is of the quality and content one would expect from a highly scientific and industrious race brought into contact with agriculture carried on under a climate and conditions and with crops of which it had little or no previous experience. The extent to which Amani was able to be of service to the German Colonial Army during the war, a reference to which may be found in the report of the recent East Africa Commission, shows what excellent use had been made of the opportunities for the study of the manufacture of tropical plant products from quinine to a particularly potent brand of whisky.

The greatest success of Amani is probably to be found in its work of plant introduction. The thriving sisal industry of East Africa is the most vigorous of its offspring, and, but for a piece of ill-luck in backing the wrong horse, namely Ceara instead of Para, there might have been a flourishing rubber industry. The handling of the coffee plantations, if one may fairly judge from present indications, showed that the assiduous collection of information cannot take the place of practical experience gained in contact with tropical conditions.

After the termination of the war an attempt was made to continue the Amani Institute as a sub-department of the Tanganyika Department of Agriculture, and Mr. A. Leechman served as Director from 1920 to 1923, when the attempt, which does not seem to have been more than half-hearted, was given up. The Institute was left in charge of Mr. F. M. Rogers, a student gardener from Kew, who, under the control of the Director of Agriculture, functioned as curator up to March this year. Sufficient funds were provided by the Tanganyika Government to keep the grounds in order, to preserve the books, collections and apparatus and to maintain the function of plant and seed distribution. Reports have been current which suggested the looting of the Institute during the war, and neglect amounting to ruin in more recent years. I was agreeably surprised to find the cultivations in excellent order, and the books, most of the apparatus, and the collections in a condition which speaks well for the preservative effects of the Amani climate as compared with that of other tropical countries with which I am familiar. Mr. Rogers has earned great credit for the thoroughness with which he has carried out his duties as custodian under conditions of isolation which would have damped the enthusiasm of most men.

The Institute is now in process of reorganisation as a central agricultural research station for the East African group of British Colonies and Protectorates, comprising Uganda, Kenya Tanganyika, Zanzibar, Nyasaland and Northern Rhodesia. This represents a vast stretch of country reaching from the Zambesi to the sources of the Nile, within which agriculture is practised at altitudes ranging from sea-level to near 10,000 feet. Whatever Amani may lack it will not be subjects for investigation.

The establishment and functions of the proposed chain of research stations in the tropical and sub-tropical colonies have formed a principal subject of discussion at the recent Imperial Agricultural Research Conference. Opinion is unanimous that there should be no interference with the full development of the territorial departments of agriculture. The work of the central station has been variously described as "fundamental," "long range", and "wide range" research, terms which it is probable that no two of us would define alike, but from which the general idea can be recognised. The officers working in agricultural departments have usually so many duties and problems pressing for attention that even the specialist in any particular branch has usually to be content if he arrives at a working solution, however empirical it may be. It will be the duty of the Research Station to seek the underlying principles from which the practice most suitable to any given set of conditions may be derived.

The broadest and most fundamental type of investigation lies in the study of soil and climate, and of the results of their interaction as expressed in the flora and fauna, both natural and artificial. An effective soil survey must be preceded and accompanied by a great deal of work on the nature and classification of East African soils. While this proceeds valuable information may be obtained by a shorter route through ecological studies.

There is another general group of what may be termed co-ordination services which the Institute may appropriately undertake. Internally these include comparative studies of the distribution and adaption of crop-plant varieties, and of the distribution and incidence of pests and diseases. Externally they include plant introduction and plant protection against the admission of pests and diseases from other countries.

Of the innumerable subjects for special investigation which offer themselves only one or two outstanding examples can be given. The conservation of soil fertility will some day become a subject of deep concern to the European settler. At present he is living on the accumulated reserves of virgin soil. Wastage

under cultivation is rapid, and wonderfully rich as the soil may be, and often is, it will not last for ever. The most general native system of regeneration is based on shifting cultivation usually with a weed or bush fallow. It is worth study to find exactly how its effects are produced, the degree of its efficiency, and its capabilities for improvement.

The problems I should select as of most urgent importance are concerned with the behaviour under East African conditions of the Arabian coffee plant. In many areas the permanence of the plantations is open to serious doubt unless appropriate methods of handling the cultivation are worked out. The trouble known as over-bearing is often serious, in which young trees suffer from serious dieback associated with what is regarded as prematurely heavy cropping. There are also peculiar interferences with normal growth attributed to extreme fluctuations of temperature. The most direct influence which can be used to control the conditions giving rise to these and other troubles is through the provision of shade, but on this subject there is confusion of counsel and the utmost diversity of practice. The establishment of principles in these matters presents primarily a series of problems in plant physiology, but will need to be approached through the combined efforts of workers in all the main branches of agricultural science.

The suggestions which I put forward as examples of the work which may be undertaken by the central research station are entirely my own, and must not be understood to commit any superior authority concerned. The subject is s ill an open one, and one which may very appropriately be discussed in a meeting of economic biologists.

SUGAR IN INDIA.

SIR JAMES MACKENNA, in a paper on the Indian sugar industry (*Journal of the Royal Society of Arts*, Vol. LXXVII, No. 3970), produced figures which show that although the population of India has increased enormously during the last three decades, the area under sugar-cane has only recently overtaken the acreage in the nineties. Imports of foreign sugar into India have in the meantime more than quadrupled, having risen from 125,000 tons in 1891-92 to 826,900 tons (Java 611,700 tons) in 1926-27. British imports of Indian sugar which were as high as 96,875 tons in 1851 have practically vanished. The decline of the Indian sugar industry and its inability to keep pace with the increased internal demand is attributed to the expansion of the industry in other British colonies and to conservatism and lack of progress in processes of manufacture. The latter is mainly in the hands of peasant cultivators who have very little capital at their disposal to improve the efficiency of their mills. It is also stated that the effective yield of juice per acre could be increased by 10 to 15 per cent. f effi cient mills were procurable.

PORTUGUESE EAST AFRICA.

ACCORDING to Mr. J. Pyke, British Consul, Lourenco Marques (1927 *Department of Overseas, Trade Report on the commercial, economic and financial position of Portuguese East Africa*), Portuguese East Africa or Mozambique, the second largest of the Portuguese colonies, is bounded on the south by Natal and Swaziland, on the West by the Transvaal, Southern and Northern Rhodesia and Nyasaland, and on the north by Tanganyika. Though undoubtedly extremely rich, the development of the province is very backward except on the seaboard and along the railway lines, serving the British hinterlands of the Transvaal, Southern Rhodesia and Nyasaland. Foreign, especially British, capital will probably become available for the development of the mineral and agricultural wealth of the interior when the stability of a sound colonial administration and the settlement of outstanding financial difficulties warrant this action.

Land Tenure.

In certain parts of the country the provincial government grants territorial concessions to entities who exercise a large measure of local control in the areas assigned to them, known as *prazos*. In return they pay a rent, the amount of which is based on the number of native inhabitants from whom they collect a capitation tax, commonly called hut-tax. Lessees are obliged to carry out certain improvements, such as road building, &c., and they administer their *prazos* through *intendentes* who are directly answerable to the district governor.

The advantage of the much-discussed *prazo* system from the point of view of agricultural development is undeniable. It gives an abundance of native labour. The placing of the native under the direct control of the private concessionnaire of the soil undoubtedly presents opening for abuse, but recent legislation abolishing recruited or forced labour, and the need of the lessee for all the labour which he can possibly obtain, appears to indicate that less will be heard of such abuse of authority in the future.

Agricultural Products.

Agricultural produce forms almost the whole of the riches of the province, and the range of altitude from the coast to the eastern frontier permits of the cultivation of a wide range of crops.

Copra.

Along the seaboard there are extensive plantations of coconut palms and two policies exist in the production of copra; both being represented in the Quelimane district where the Madal Company is obtaining about 10 tons per 1,000 palms from 225,000 palms, by maintaining their plantations in a high state of cultivation as against 4 tons per 1,000 palms obtained by the Boror Company from over a million palms, without much cultivation. Most of the produce

of the smaller enterprises, as well as the native-produced copra, is secured by the second method, not perhaps as the result of deliberately adopting this policy, but owing to lack of capital. European-owned plantations of coconuts cover about 7,400 acres, and about 25 per cent. of these belong to British companies. One Portuguese company has planted on a large scale, but its efforts to maintain its plantations in condition are somewhat half-hearted. Most of the balance under palms is in the hands of Germans, of whom there were, at the commencement of 1925, 87 in the territory out of a total foreign population of 121. The larger part of the export is destined for Marseilles and the Continent.

Sisal.

The cultivation of sisal has attained some importance during the past few years, and it grows best on the higher and drier lands of the interior, and few successful enterprises exist within thirty miles of the coast. The chief characteristics of the soil are siliciferous clays, and the absence of lime does not prevent good yields being obtained. From 430 to 1,275 lb. per acre are secured on the plantations mentioned, with an average of about 1,100 lb.

Until recently, the natives have shown great dislike to working on sisal plantations, owing to the fact that the fields were indifferently cleaned and the plants placed close together, with the result that workers suffered considerably. Now, however, the tendency is to plant 7 feet apart, and to eliminate the variety with spikes along the side of the leaf, so that it is hoped that, even with the approaching abolition of recruited labour, a sufficiency of volunteers will be found to enable the industry to progress normally. The life of the plant is from six to eight years, the shortness being due to excessive moisture and the richness of the soil; the crop yield is from three to five years. Propagation is effected from "bulbils" and suckers, chiefly from the latter, which are removed from the parent plant when about a year old and about 12 inches high; cutting is commenced in the third or fourth year. Some of the companies cut twice a year and others as often as every three months: twenty-five leaves a year is the average output of a plant. The fields are served by decauville, the waggons, holding about two and a half tons of leaf, being drawn by men or oxen in the side alleys, and by small locomotives on the main routes to the factories. British, American, German, and a few French decorticators are used, the British machine being apparently most favoured on account of its large yield, from 5,000 to 5,300 lb. being produced per day. The fibre is immediately washed in running water and is placed to bleach and dry for 24 hours on wires, bamboos or sisal cord stretched between uprights in the open: a longer drying operation appears to result in a spotted and yellowish fibre, the tensile strength of which is also affected It is then brushed by hand or machine, sorted for length (2½ to 4 feet) and colour, and baled in hydraulic presses under a pressure of over 2 tons per square inch The refuse of tow, about 8 per cent. of the weight of the fibre before brushing, is also baled and exported.

Producers would do well to co-operate so as to market their output in bales of the same weight, the present practice resulting in bales varying from 2 cwts. to 250 kilos.

The enterprises which are at present engaged in the production of sisal fibre have shown that the Mozambique product compares very favourably with the best Indian Mexican and Tanganyika fibre, and the industry shows signs of development.

Sugar.

The most important centres for the production of sugar are in the territory of the Mozambique Company on the Buzi River, and at Caia and Marromla, and to the north of the Zambesi, where the Sena Sugar Estates, Ltd., owns large factories at Mopeia and Luabo.

Production during the last two years has fallen by about 50 per cent., owing to the disastrous floods during the wet seasons, which rotted a large proportion of the cane. The Busi Colonial Company near Beira, which produced over 14,000 tons in 1924 only succeeded in obtaining an output for 1926 of about 6,000 tons. The completion of the large modern factory of the Sena Sugar Estates at Luabo, with a capacity of 50,000 tons, will enable this concern to increase its output considerably, and, in spite of the fact that it is not yet fully equipped, an output of 60,000 tons is estimated for the coming season.

Cotton.

The cultivation of cotton, both for lint and seed, has been developed considerably during recent years with fairly satisfactory results. Several plantations have started operations in the Lourenco Marques district, and native-grown cotton is an important industry in the territory of the Mozambique Company. Modern ginneries exist at Lourenco Marques and Beira, as also at Chemba on the Zambesi, where the Mozambique Industrial and Commercial Company have organised an experimental farm of over 12,000 acres.

An American expert investigated the prospect of this industry but in his opinion, the uncertain rainfall and the prevalence of disease make the future uncertain, unless irrigated land becomes available for the cultivation of cotton: as stated elsewhere, a scheme has been prepared for irrigating the Limpopo Valley, which would appear a suitable situation for cotton growing. The fall in world values of cotton has resulted in a diminution of this culture by Europeans, and it seems to be replaced by sisal to which two important companies are now giving attention, with apparently fairly satisfactory prospects. Among other crops grown in the province are ground-nuts, mafiera, beans, caju nuts, maize, sesame, millet, rice, tobacco, coffee and tea.

RECLAIMED RUBBER MANUFACTURE.

The influence of reclaimed rubber on the rubber industry is becoming so pronounced that some facts concerning the manufacturing processes involved in the reclamation of rubber and the difficulties encountered may be of interest. The following is abstracted from an article by P. S. Shoaff, published in *Industrial and Engineering Chemistry*, Vol. XX, p. 152.

The factors to be considered in the production of good reclaimed rubber are numerous. Firstly, the properties of the scrap rubber used will affect those of the final product. Different types of scrap rubber will require different treatment for satisfactory reclamation. The first operation, therefore, is to sort the scrap rubber into grades suitable for similar treatment. This is by no means an easy process since much depends on the previous treatment, exposure, age, and general physical and chemical condition of the scrap. In the second operation, the selected scrap is ground finely to a uniform size. If the particles formed are too large, the later milling and devulcanization processes must be correspondingly increased. If the particles are too small, the final product is inclined to be tacky.

Fragments of metal, the chief impurity in the ground material, are removed with the aid of magnetic separators. It would be desirable to remove cotton fabric, but at present no satisfactory and economical method has been devised.

Devulcanization is the main chemical process in the reclaiming of rubber and the previous steps are merely to reduce the scrap into a suitable condition for this process. The object of the devulcanizing process is primarily to restore as far as possible the physical condition of the original rubber. Cotton fabric and free sulphur present in the scrap are removed simultaneously. The mechanism of the process is not completely understood. By some it is regarded merely as a continuation of the grinding process, the particles being reduced to a much smaller and more uniform size. It is more probable, however, that chemical changes take place and that the rubber molecules are actually depolymerised. The presence of oxygen is essential as it acts as a catalyst to the re-action.

The treatment varies according to the nature of the scrap rubber. For fabric free materials and when the removal of sulphur is not required, the ground scrap is treated with steam under pressure for from eight to thirty hours, according to the character of the material. If the removal of free sulphur is desired the scrap is treated with caustic soda solution at atmospheric pressure. It is then washed and put into a heater provided with an agitator. The residual moisture is driven off and the devulcanization is then obtained under pressure by indirect heating.

The more common 'alkali process,' which is used for rubbers containing cotton fabrics consists of treating the ground scrap with caustic soda solution in steam heated digestors. The cotton cellulose is thereby converted into a soluble form, nearly all the free sulphur is removed, and the rubber converted to a plastic condition. The strength of the soda solution used and the time of heating depend on the nature of the original scrap. In some cases softening agents such as coal tar, pine oil. &c., are added to form a 'smooth' reclaimed product. Great care must be exercised in their use, however, as they may cause difficulties in later stages. Some softeners improve the ageing of the final rubber, others have a deteriorating influence.

The devulcanized material contains residual caustic soda, sulphur compounds, and other impurities. These are removed by placing the material in large tanks which are alternately flushed with water and drained. The washing is continued until, on boiling a sample with water for eight hours, less than .01 per cent. of soda is obtained. The wash water drained from the tanks contains a certain amount of fine rubber particles which it is profitable to recover. In some cases they are recovered by fine filtration; in others by allowing them to settle first and removing the solid matter from the sludge so formed by filtration. The solid matter thus recovered is added to the main body of material just before the drying operation.

The washed material is then 'dewatered,' as a preliminary to drying, by means of screw presses or centrifugals. The moisture content is thereby reduced to about 30 per cent. The drying is performed in a rotary drier by a current of hot air. The maximum drying temperature used is in the region of 300°F., higher temperatures make the final product tacky.

The dried material may contain lumps and be in an uneven condition. Milling and refining is required to break up these lumps and render the reclaim plastic. The rubber is therefore passed through closely set mills to which it is continuously returned until a sufficiently plastic condition is obtained. It is then passed through a rough refiner or breaker, and finally through a finishing refiner. The plasticity of the rubber is greatly increased by prolonged milling and refining on cold machines. If the temperature of the mills and the refiners is above 200°F., a 'grain' is produced and the elasticity and tensile strength correspondingly reduced.

The refined reclaim is finally forced through screens of twenty-six to thirty mesh in order to remove any small pieces of metal or other foreign material. This final process is known as straining.

The reclaiming process is at present far from perfect, for the final product has never the solidity and the elasticity of raw rubber. The difficulty is that the changes brought about in the vulcanizing and in the ageing of rubber are

mainly physical. Removal of the vulcanizing agent will not necessarily change the physical properties of the scrap material to those of the original rubber. It appears that in the devulcanizing process the rubber molecules have to be depolymerised or disaggregated, and removal of sulphur alone will not bring this about. Catalytic action may produce a solution to the problem.

H. H. C.

ENTOMOLOGICAL NOTES.

Compiled by the Department of Entomology.

1. Insect Transmitted Plant Disease.

In an interesting article in *Ecology* for October, 1928, entitled "Increase of Insect Transmitted Plant Disease and Insect Damage through weed destruction in Tropical Agriculture," George N. Walcott, *Service Technique du Department de l' Agriculture*, Port au Prince, Haiti, discusses the effect of weed destruction in relation to the spread of mosaic disease in sugar-cane fields and serious injury to sisal plants by caterpillars as a direct result of weeding.

It is often stated that weeds in cultivated fields should be destroyed because they harbour insect pests and plant diseases. The author shows, however, in the case of the corn aphis (*Aphis maidis*) and its relation to the transmission of mosaic disease, that this insect attacks sugar-cane only when other food supplies fail, as it appears to have a positive dislike for sugar-cane. The natural and preferred food plants of *Aphis maidis* appear to be small grasses in the cane fields. When a field of young cane is cultivated and the grasses or at least the aerial portions are destroyed the winged aphids fly out of the cane fields in search of their preferred food plants. The wingless forms crawl over the surface of the ground in search of food and in this way the cane plants become infested.

"If the corn aphids seldom or never leave their preferred food plants in the field for sugar-cane, unless forced to this unnatural and disliked host, then, by not forcing them to leave their normal host, practically all possibility of their transmitting mosaic disease of sugar-cane is eliminated."

However, it is not possible to avoid weeding in cane fields and in practice the control of mosaic disease must depend on the employment of other methods, but it should be emphasized that the destruction of weeds in the field is primarily the cause of rapid spread of the disease in the sugar-cane when the aphis is found on the grasses in cane fields where mosaic disease occurs.

Another striking instance of the injury to a crop plant as a result of weed destruction is noted. On a plantation in Haiti weed growths were supporting great numbers of several species of caterpillars, including the cutworms belonging to well-known genera. When their food plants (weeds) were destroyed in the mixed cultivations of sisal and cotton in which they were growing, the insects, particularly the cutworms, promptly attacked the cotton and sisal plants.

The author summarizes his paper as follows:—"The vector of the mosaic disease of sugar-cane, *Aphis maidis* Fitch, in cane fields ordinarily lives on small grasses, and when these are destroyed by cultivation, the aphids are forced on to the cane. A single experiment has shown that the more often cane fields are cultivated, the higher is the mosaic disease infection of the sugar-cane, but these results have never been confirmed.

A more common and less complicated result of destroying weeds, at a time when they are being devoured by caterpillars, is that the caterpillars are forced to attack the crop to obtain sufficient food to complete their growth. The instance noted is of cutworms, *Prodenia ornithogalli* Guenée, and *Zylomiges sunia* Guenée, feeding on *Boerhaavia erecta* L., being forced to eat the leaves of cotton and even of sisal, on a plantation in the Cul-de-Sac plain of Haiti."

H. A. B.

* * *

2. The Tsetse Fly.

An interesting review of an article contributed by Dr. W. Frantzen to *Matériaux pour l'étude des calamités* on the geographical distribution and economic significance of the tsetse fly in Central Africa, appears in the *Geographical Journal* (Vol. LXXII, No. 4). The writer, it is stated, is inclined to take a pessimistic view of his subject, and to be critical of the results obtained by the African administrations. The *Glossina palpalis* is found in Central Africa between 16°N. and 13°S., west of the meridian 35°E.; *Glossina morsitans* is found on the north and east of this area, and extending also farther to the south. The fly is rarely encountered at altitudes over 1,200 metres. The *Gl. palpalis* frequents, in general, the fringing woods of rivers and lakes and the deltas and mangrove swamps of the West Coast: the *Gl. morsitans* occurs in the savannah type of country. These are not hard-and-fast distinctions, for there are exceptions, and the whole subject requires further study. The exact extent of the ravages of sleeping sickness is difficult to determine in the absence of continuous accurate censuses: the population of French Equatorial Africa, stated to be 8-9 millions in 1913, had declined to 2.8 millions by 1921, though this decrease obviously cannot be attributed solely to sleeping sickness. A similar loss of two-thirds is recorded in the Kisante district of the Belgian Congo between 1900 and 1910. At the height of the epidemic, between 1901 and 1906, the annual death-rate per thousand on the Buvuma and Sesse Islands of Lake Victoria rose to 428 and 133. When it is remembered that, for its development, Africa is under-populated, and that, in addition, human labour has to replace animal transport, the economic effects of this disease will be apparent. The very effect of opening up large areas has often been to spread

infection, especially when labour has been concentrated, *e.g.*: for road making. The efforts to prevent its extension by setting up barriers to intercourse between peoples have directly affected trade, already handicapped by transport difficulties. Similarly, areas from which valuable palm-oil or rubber might be obtained are isolated by the disease, and, but for the fly, an export cattle trade would be possible. On the other hand, economic development, apart from the increased opportunities for contact it produces, has sometimes widened its range. An example is cited where irrigation of banana trees has been responsible for an epidemic. Dr. Frantzen also considers the methods taken to fight this scourge. The difficulty of resettlement on a large scale in an uninfected area lies in adapting the settlers to their new surroundings. This was particularly so when fishing peoples of Lake Victoria were moved away from its infected banks. The value of large concentration camps is also problematical, while the difficulties of wholesale inoculation are obvious. The solution appears to lie in the clearing of the bush and cultivation of wide areas around each village. It is often difficult to secure the destruction of sacred or valuable trees, though the latter may be replaced by economic crops, and small villages find it impossible to keep the undergrowth down. The absence of cattle often means a debased standard of life for the natives, and a declining birth-rate. The problem is to break the vicious circle of disease, hunger and further disease.

JAVA SUGAR.

FOR the current Java crop two-thirds of the fields have been planted with P.O.J. 2878 cane and the output has risen for this and other reasons from 2,359,050 long tons in 1927 to about 2,931,000 tons in 1928. The cost of production of this crop is put at about 10.50 to 10.75 florins per quintal (9*s*. to 9*s*. 2*d*. per cwt., or 1.92 to 1.97*c*. per lb.) and somewhat lower still for 1929; and it has been calculated that if the final half of this year's crop fetches no more than Fl. 11 per 100 kilos, the average price for the whole crop will be about Fl. 12.87, as compared with a cost of production not exceeding Fl. 10.75, which means a profit of some 20 per cent. Next year will probably see the maximum acreage planted in P.O.J. 2878, after which Java can hardly expect to see any further marked improvement in her returns, for she is unable owing to her land laws to increase her acreage to cane any further. The 1929 crop is at this stage expected to reach some 300,000 tons more than the present one; but that would appear to represent the high water mark in the near future. The 1928 crop was not only favoured by the new cane variety, but also by unusually propitious weather which may not be the experience of 1929 and 1930.—(*International Sugar Journal*, Vol. XXX, No. 359, p. 571.)

CORRESPONDENCE.

WITCH-BROOM DISEASE.

A reply to Criticisms.

DEPARTMENT OF AGRICULTURE,
TRINIDAD AND TOBAGO.

Dear Sir,

In the January number of *Tropical Agriculture* published during the past week, there is an article on *Witch-Broom Disease* by Dr. H. Briton-Jones, based on the Bulletin by Mr. F. Stell, recently issued by the Department of Agriculture. After giving a brief summary of the contents of the Bulletin, Dr. Briton-Jones deals with points on which he disagrees with Mr. Stell. The Department of Agriculture is concerned not only in itself carrying out control measures on some 350 acres affected with the disease, belonging to small holders, but in advising the few estate owners who have the disease on their properties. It would be very unfortunate at this junction if any feeling of lack of confidence in the practice and recommendations of the Department were created in the minds of cultivators. This may easily happen when the Professor of Mycology of the Imperial College of Tropical Agriculture publishes an article giving at some length reasons for disagreeing with the Mycologist of the Department of Agriculture. It will be well therefore, to examine closely into the points of issue.

The Destruction of Diseased Material.—Dr. Briton-Jones summarizes Mr. Stell's recommendations in these words: "To be effective it is considered that the infected material on the trees should be worked every two weeks. After the removal of diseased flower cushions it is recommended that the exposed surfaces should be tarred. All diseased pods should also be collected and all infected material buried at a depth of a foot and covered with earth. It is stated that if this is done the fungus will perish."

He follows this by pointing out certain theoretical objections to burying prunings, &c. in the soil of the affected area (this is dealt with later) and concludes "Oil is cheap in Trinidad and the diseased prunings could be burned without much difficulty if the work is properly organized."

The impression left on the reader, ignorant of the facts will be that the Department is burying diseased prunings because, presumably, of lack of ability to organize the work properly so that they can be burnt.

Dr. Briton-Jones obtains this point on which to base criticism of the Department's work by misquoting Mr. Stell. He omits an essential part of Mr. Stell's recommendation, which reads "It would be a counsel of perfection to advocate the burning of all diseased material. But when this is not practicable the diseased material can be buried," &c.

Since the end of June the Department has worked a total of nearly 3,000 acres (going over the same areas several times) and all the diseased material collected has been burnt—oil being used when necessary.

Dr. Briton-Jones was a visitor to the scene of operations as recently as 28th November, and the last item shown him in the field was the burning of a day's collection. On this point, therefore, his advice resolves itself into a recommendation to the Department to adopt the practice it has been following regularly for the last six months.

The Burying of Prunings.—Mr. Stell recommended amongst measures of indirect control (*i.e.*: as opposed to the collection and destruction of actual diseased material) annual pruning of the cacao trees and added "In view of the possibility of some of these prunings being already infected, it would be good policy to make trenches between the rows of trees, burying the prunings and covering with earth. This system which has been practised with success at the Department's River Estate for some years, is coming into increasing favour in cacao cultivations in the island. It should prove a good sanitary, as well as cultural operation, in the infected territory."

In commenting on this Dr. Briton-Jones says: "The soil at River Estate is a light, sandy loam which can be effectively drained without much difficulty. As explained by Stell, the soil in the Witch-broom areas is low-lying, flat, and is a heavy clay. The difference in the soil texture makes all the difference in regard to the best method of disposing the prunings. If they are buried in trenches between the trees on the heavy, low-lying lands, there will be distinct danger of an outbreak of disease far more destructive than Witch-broom disease, viz.: *Rosellinia* Root Rot. When the prunings decompose in the soil, they are reduced in bulk and the soil over-lying them sinks in consequence, thus forming a water-logged strip throughout the plantation. The acidity of the soil will probably increase in this region and the water-logged, acid, decomposing mass of vegetable matter will render conditions extremely favourable not only to *Rosellinia* but also to Die Back. The normal prunings should be used as a surface mulch."

It is necessary to point out that in the system of trenching as practised and advised by the Department, the material to be buried is put into a shallow, continuous trench, and the earth removed in making the trench is put back on top, forming a bank one foot or more in height. This sinks very slowly and there is very little likelihood of any depression at all being found. Moreover, the experience of the Department has not been limited to trenching in the lighter soils of River Estate, good results have also been obtained in heavy clay soil and when conditions warrant it (even in some parts of River) the ends of the trenches are made to open into the drains, so that, for a time at any rate, the trenches serve as additional sub-soil drains. The officers of the Department have had many years practical experience in dealing with *Rosellinia* disease, and have sufficient knowledge of the conditions of cacao cultivation to avoid making recommendations likely to increase liability to this disease.

The suggestion to use the prunings as a surface mulch is rendered of less value owing to much of the worst infected areas being subject to heavy floods. In the recent exceptional flood the water had been over five feet up the cacao trees in places. By burying the material there will be less likelihood, in the possible event of it being infected, of it being washed down to spread infection elsewhere.

Drainage.—Mr. Stell recommended improving the drainage in the affected areas, stating that "It was found by investigators in Surinam that good and bad drainage had no visible effect on the susceptibility of the trees to Witch-broom because the disease is present both on strong and weak trees. What they found was that good drainage strengthens the trees and in this way makes them more resistant to the effects of the disease."

Dr. Briton-Jones in discussing this says: "It is evident that an improved system of drainage will reduce the humidity of the atmosphere above the ground and within the crop. *Ipso facto* it will reduce the incidence of the disease."

Dr. Briton-Jones may be quite correct but there has been no opportunity yet of putting this question to the test in Trinidad.

Tarring.—It was recommended that after removal of diseased cushions, &c. the exposed surfaces should be tarred. Dr. Briton-Jones points out the disadvantage of using tar and recommends Brunolinum, Carbolineum, Solignum, &c. This criticism is caused by Mr. Stell speaking of tarring, as is commonly done in Trinidad, to denote any painting over of wounds. As a matter of fact the material which has been used has not been tar but road oil, which has been found by lengthy experience on cacao estates to be satisfactory for such purposes.

Dr. Briton-Jones concludes his paper by suggesting some points on which further information, to be obtained by research, is desired. The Department is not specially equipped for research work and its small available staff is fully occupied in putting into practice the results of the research work already carried out in Surinam. As has been already stated by the Director of Agriculture, the Department will be only ready to put into practice any other methods which may be proved of value as the result of further investigations, but these are not yet forthcoming.

Yours faithfully,
W. G. Freeman.

Imperial College of Tropical Agriculture,

To the Editor,

Dear Sir

The writer is unhappy in the thought that the Department of Agriculture of Trinidad and Tobago has interpreted his article in the last issue of this Journal in the light of an attack on the work of the Department and the manner in which it is being carried out. It is true that the writer expressed his disagreement with some of the measures recommended but there is nothing unique in one scientist disagreeing with another on certain points. It is essential, however, to the advancement of scientific knowledge that differences of opinion be expressed freely and without prejudice. The writer has nothing but praise to offer the Department of Agriculture of Trinidad and Tobago for the energetic manner in which it has applied itself to its difficult task.

The points on which the writer differs in his opinion from those held in the Department of Agriculture have been dealt with in the above letter, and the following comments are made :—

The Destruction of Diseased Material.—There appears to be but little difference in this connection. It is stated, however, that the essential point of Stell's recommendation previously omitted by the writer is : " It would be a counsel of perfection to advocate the burning of all diseased material. But when this is not practicable the diseased material can be buried," &c. Further, that all diseased material has been burnt. . . oil being used when necessary. The writer would repeat that all diseased material should always be burned (*vide* below *re* burying) and that oil is always necessary. Oil was not being used on the 28th November when the writer visited the affected areas.

The Burying of Prunings.—(*i.e.: as opposed to the collection and destruction of actual diseased material*). The burying of such prunings is advocated by the Department of Agriculture for the reasons given above and the writer disagrees for the following reasons :—

(i) The trench dug will become waterlogged whether it is covered with a mound of loose earth which sinks slowly or does not sink. In actual practice it does eventually sink and forms a depression. This can be seen quite readily in Trinidad on many acres under Coconuts where the drain has been changed in its position from near the palm to the centre of the original bed. In the above letter it is stated that when conditions (*not defined*) warrant it the ends of the trenches are made to open into the drains so that for a time at any rate the trenches serve as additional subsoil drains. This was not mentioned in the booklet when the method was first discussed and the fact that it is now brought forward indicates the importance of its being previously omitted. It does not, however, eliminate all the objections. (ii) The pruning alluded to is done in the dry season and if a shallow, continuous trench is dug which yields sufficient soil to make a mound a foot or more high on top of the buried prunings it is, nevertheless, deep enough to cause severe root pruning of the cacao trees. (iii) If, as stated, there is danger of possible infection from some of these prunings it follows that it is intended to bury in a fresh state. Between the time of burying and the time when the rotted prunings become available as plant food certain microbiological changes occur. It has long been known that if these changes are allowed to take place in the soil in which a crop is growing or is to be grown the result is deleterious to the crop. The harmful effect of burying green manure has been demonstrated by Fred.—(*Journ. Agric. Res.* Vol. V, p. 1161-1176, 1916). He showed that seed and seedlings sown immediately after ploughing in green plants as a manure were killed. Viljoen and Fred—(*Soil Science*, Vol. XVII, p. 199, 1924)—also found that the burying of undecomposed plant tissue in the soil was unfavourable in its action on the immediate development of plants.

Tarring.—The writer objected to tar in favour of the better wound dressings mentioned above. From the above letter it appears that tarring in Trinidad denotes any painting over of wounds. In this particular instance "tarring" means painting with road oil whereas in another, presumably, it might mean one of many other fungicidal wound dressings.

Yours faithfully,

H. R. Briton-Jones.

SUGAR-CANE PROPAGATION.

The Java method for rapidly propagating a valuable new seedling is as follows : A special small garden plot handy to water is put in good order and manured. Next the sets are planted, giving them at least five feet each way, and covered with not more than a half inch of soil. They are watered and given the best of treatment in every respect. After growing for a couple of months each set should have produced about 20 small shoots. The soil is then carefully removed from the largest shoots, one by one, and those which have produced any of their own shoot roots (except those direct from the set, which should be left) are carefully cut off and immediately planted in another place to produce another stool ; the soil is carefully replaced around the stools which are left. The shoots must not be removed in this way before they are forming their own roots, otherwise they will not grow. Their leaves should be cut off and they should be planted, not upright, but at an angle of 45 degrees, to induce more rapid stooling out from the butts, and so that the young shoots which grow may be more readily cut off. They need careful watering and tending in order to get them to grow successfully.

The value of the method is illustrated by the case of P.O.J. 2878, which in August, 1922, existed as a single stool one year old. In 1927 this stool had been increased sufficiently to plant about 45,000 acres.—(*Facts About Sugar*, Vol. XXIII, No. 33.)

TROPICAL WORLD NOTES.

British North Borneo.

It is stated in the progress report of the British North Borneo (Chartered) Company for 1927, that the total trade turnover of the territory in 1927 was £2,848,000, a slightly lower figure than that recorded in the previous year—£2,851,000. Exports were valued at £1,803,000, as compared with £1,937,000 in 1926. The decline of about 7 per cent. was wholly attributable to the decrease in the value of estate rubber exported.

Although rubber maintained its supremacy, accounting in 1927 for nearly 60 per cent. of the total value, the quantity shipped was 6,602 tons, as compared with 6,079 tons in 1926, an increase of 523 tons; but, owing to the fall in prices, the value decreased from £1,260,000 in 1926 to £1,068,000. There was a marked improvement in the timber industry, which ranks next in importance to that of rubber. Exports, which, owing to the troubles in China, had fallen in 1926 to 1,965,000 cubic feet, valued at £160,816, rose in 1927 to 2,514,000 cubic feet, valued at £211,782. This recovery was primarily due to more normal trading conditions in South China. Tobacco maintained its position as third on the list of exports. The value of tobacco shipped was £189,574, as compared with £136,014 in 1926.

Progress in the coconut industry, which has shown such healthy development in the past, was checked by the severe drought experienced in 1926, and by unremunerative market prices. Exports of copra were 3,222 tons, valued at £54,344, as compared with 4,833 tons, valued at £90,136, in 1926. At the end of the year the outlook for this industry was brighter.

Two forest products figure prominently in the list of exports for 1927, damar, the gum or resin used for making varnish, and rattans, exports of both showing good increases. Attention has often been called to the possibility of manila hemp being successfully cultivated commercially in North Borneo. This product has grown well on a large estate in the vicinity of Tawau, and it is of interest to note that in 1927 a few small holders in the Tawau locality, began to plant up manila hemp experimentally. — (*The Chamber of Commerce Journal*, Vol. LVI, No. 758.)

* * *

Gambia.

The report for 1927 by Mr. Densham Smith, Receiver-General of the Gambia, on trade shows the total commerce to be £1,862,376, an increase of £307,073 over 1926, and of £125,409 over 1923. The improvement was distributed over all the principal articles of trade, both in imports and exports.

The imports amounted to £863,376, an increase of 32.6 per cent. over 1926.

Exports amounted to £999,000 or an increase of £5,384 over 1926. Of the total, £967,941 represented ground-nuts, of which 69,240 tons were exported. Palm-kernels showed a further small increase to 719 tons, value £11,611, while hides trebled in quantity and value to 343,894 lb. and £9,288.

The most noticeable feature in regard to the direction of trade is the growing importance of France to the Gambia. In 1926, the United Kingdom supplied 44.3 per cent of the imports and took 37.3 per cent. of the exports, whereas last year the respective proportions were 38.8 per cent. and 8.2 per cent. Practically the whole of this lost trade went to France, for she increased her proportion of imports from 24.6 per cent. to 30.7 per cent., and of exports from 25.8 per cent. to 42.1 per cent. Holland and Germany took 20.7 per cent. and 19.7 per cent. respectively of the exports, as compared with 16.5 per cent. and 14.3 per cent. in the previous year.

* * *

Uganda.

The recently issued annual report of the Uganda Department of Agriculture states that there was a considerable increase in the use of motor transport during the marketing of the cotton crop, and keen competition to secure cotton resulted in ginners and other buyers maintaining fleets of light motor-vans. These vans toured the countryside for prospective sellers, who were then transported, together with their cotton, to the buying point, either at a nominal rate or without charge. Referring to the position of the ginneries in the Protectorate, the report mentions that in spite of the fact that the existing number was far in excess of requirements four new ginneries were built during the year. Uganda now has 192 ginneries, and more than half of these, the report states, are a serious handicap to the country and the cotton industry.

In respect of coffee, the Agricultural Department states that returns received from European and Indian plantations show that the area under *Coffea Arabica* was approximately 13,561 acres, a slight increase over the previous year's figure. In other parts of Uganda more attention was given to *Coffea Robusta*, and the area under this crop showed an increase from 2,483 acres in 1926 to 4,682 acres in 1927. The native coffee industry made further progress, and the demand for seedlings was greater than the supply. The area under rubber remained at approximately 11,828 acres.

The report adds that experimental work in tobacco planting was started in the Bunyoro district in 1927, with very promising results. It is mentioned further that increasing interest is being shown in tobacco by both European and native planters, and that if progress is maintained on present lines there is every indication that tobacco cultivation is likely to play an important part in the development of Uganda.—(*The Times Trade and Engineering Supplement*. No. 538, Vol. XXIII.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Synthetic Nitrogenous Fertilizers.

The following notes on some synthetic ammonia products are taken from an article entitled "Economic Relationships between Nitrogen and Fertilizers," published in *Industrial and Engineering Chemistry*, Vol. XX, p. 1133.

Sulphate of Ammonia.—Made by treating finely ground gypsum with synthetic ammonia and carbonic acid; the resultant sulphate liquor is evaporated, crystallized. It carries 20.6 per cent. nitrogen.

Leunasalpetre.—Carrying 26 per cent. nitrogen, is a double salt of nitrate of ammonia and sulphate of ammonia, with 6.50 per cent. of nitric nitrogen and 19.50 per cent. of ammoniacal nitrogen. This material must be used with care or its nitric nitrogen will be lost and its sulphate of ammonia cause serious caking troubles in complete fertilizers. It also becomes very hard on long storage.

Calcium Nitrate.—Testing 15.5 per cent., nitrogen, is the result of treating limestone with nitric acid, neutralizing the excess acid, filtering, evaporating, adding 5 per cent. ammonium carbonate and drying by compressed air spray. It is very hygroscopic and is shipped in specially prepared packages. Its use in fertilizer is not satisfactory, but it will find general use as a top dresser.

Calurea.—Testing 34 per cent. nitrogen, with 7 per cent. in the nitric form and 27 per cent. in the amide form. It is also hygroscopic and its use in fertilizer will be limited. It can be used to better advantage as a top dresser.

Cyanamide ($CaCN_2$).—A lime compound of cyanogen, testing 20 per cent. nitrogen. Its use is very limited by its revertive action on available phosphoric acid due to the lime content of the cyanamide. It is also somewhat objectionable to handle.

Ammo-Phos ($NH_4H_2PO_4$).—A mixture of phosphoric acid and ammonia, producing monoammonium phosphate, testing 10 per cent. nitrogen and 45 per cent. available phosphoric acid. This is an excellent fertilizer material and can be used in any quantity with any other material. It is well adapted for tobacco on account of its freedom from the sulphate element. Last year (1927-28) the production is given as 55,136 tons, largely exported.

Nitrate of Potash—Testing 13 per cent. nitric nitrogen and 44 per cent. potash, is an excellent fertilizer material, less hygroscopic than nitrate of soda. It is a good material for tobacco where chlorine is objectionable.

Urea. ($CO(NH_2)_2$).—Testing 46 per cent. nitrogen in the amide form is made from ammonia and carbonic acid, liquified at high temperatures, producing a fused mass of urea and ammonium carbonate, which on distillation leaves the urea in solution. The product is too concentrated for ordinary fertilizer use. At present it carries a 35 per cent. *ad valorem* duty and only 600 tons were imported last year.

Domestic Synthetic Sodium Nitrate.—Testing 16 per cent. nitrogen, will be found on the market next spring. Samples of this product appear to be in better mechanical condition than the Chilean product. Will not have to be ground. In appearance it is like Arcadian sulphate of ammonia.

* * *

Raw Materials.

The quantity of raw material produced annually by the farmer, waiting to be transformed into goods of general use, is enormous. Although some is used on the farm much is wasted. It is a potential source of income for the farmer and is merely waiting for the chemist to find processes to utilize it.

The vast quantities grown are illustrated by the following figures, showing the potential sources of lignin in the United States alone.

Raw Material.	*Annual Production Tons.*	*Lignin Per cent.*	*Lignin Present Tons.*
Cornstalks	100,000,000	20	20,000,000
Cereal Straws (excluding corn)	60,000,000	20	12,000,000
Corncobs ..	20,000,000	25	5,000,000
Oat hulls ..	3,000,000	22	660,000
Cottonseed hulls	1,800,000	25-30	450,000
Flax straw ..	2,200,000	20-25	440,000
Peanut shells ..	70,000	30-35	22,400
Total	187,070,000		38,572,400

The freight charges on such raw material would necessarily be high. If processes are found for its utilization, it is probable that there will be a migration of factories to agricultural districts. Such processes may therefore influence considerably the distribution of population. The demand for these materials would be of vast importance to tropical countries where the amount of waste vegetable matter is great. It may result in increased population of tropical countries. —(*Ind. & Eng. Chem.* Vol. XX, p. 882.)

* * *

Soil Acidity and Sugar-Cane Growth.

In an article which appeared in *Archief Suikerindustrie*, 1928, 36, pages 511 to 516, Dr. O. Arrhenius describes his experiments in Java, on the growth of the cane P.O.J. 2878 on soils of reactions varying from pH 4.5 to pH 8.5. His results show that a neutral reaction gives the highest yield, and, moreover, that the quality of the cane is affected more than the quantity. The question of toxic aluminium in sugar-cane soils only becomes important for soils of reaction value less than pH 4.5, and therefore is of little interest for Java. Out of three hundred soil samples examined, none gave any test for toxic aluminium.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Synthesis of Sucrose.

The following summarises a review by E. F. Armstrong in *Nature*, October 13th, 1928.

The synthesis of cane sugar in the laboratory has brought to triumphant completion a long chapter of endeavour on the part of the chemist. The first experiments to determine the empirical formula of cane sugar date from LAVOISIER, though it was only definitely established by LIEBIG in 1831. Whilst the question of the constitutional formula of the sugars, and of cane sugar in particular, has persistently occupied the activities of many chemists, the chief progress made will always be associated with the name of EMIL FISCHER, whose achievement in unravelling the complex stereochemical relationships of the isomeric hexose sugars and in effecting their synthesis stands second to none other in the domain of organic chemistry. Sucrose was shown to be a compound of the two simple hexose sugars, glucose and fructose. It also became clear, partly owing to the work of TOLLENS, that glucose and fructose, when in combination with other substances, existed preferentially, if not entirely, not as aldehyde and ketone respectively, but behaved as if they had the structure of compounds containing a carbon-oxygen ring. For a long time this ring was considered to consist of four carbons and oxygen, though it is true that the assumption is based mainly on the analogy with the acid lactones and was without any definite chemical evidence. The hypothesis gave a ready explanation of the existence of two isomeric series glucose derivatives and of isomeric glucosides. The constitutional formula of cane sugar was formulated by FISCHER and by TOLLENS on the basis of a four carbon oxygen ring structure for its components and many attempts were made to effect its synthesis by combining them or their derivatives in synthesizing natural products. In no case were these efforts—and they were numerous in the years 1890 to 1910—rewarded by success. A claim by MARCHLEWSKI in 1891 has never been accepted by sugar chemists and even the possession of crystalline acetochloro-derivatives of the sugars failed to give the much-sought-after cane sugar. The work of the St. Andrew's school started by PURDIE, particularly of IRVINE, in studying the methylated derivatives of the carbohydrates opened a new field of investigation, out of which it was found that glucose reacted in other forms than the accepted stable ring and afterwards that the supposed ring structure of glucose itself had to be challenged. The work during the next decade, after some disillusions, has evidenced further complexity in this already complicated field. Suffice it to say that it has been proved for each of the sugars that it can react in more than one ring form according to circumstances, whilst the particular ring form present in reference compound has been studied. In this connexion the work of HAWORTH deserves the highest possible recognition. There was thus established an up-to-date formula for sucrose-differing very little, it is true, from that of FISCHER and TOLLENS—which enabled once more hopes to be held out of effecting the so long sought synthesis. Hopes, but no certainty, for, as workers in the field of sugars know well, the experimental difficulties are extreme because, whilst the glucose element in sucrose is in the stable so-called *a*-modification, easy to make and to purify in the form of its compounds, the fructose element is in the *g*-modification, which is unstable, difficult of isolation, even in its derivatives, and likely to change. Many efforts of a thoroughly scientific character to effect the synthesis of sucrose from the requisite derivatives of *a*-glucose and *g*-fructose have met with no better success at the hands of IRVINE and his school, of HAWORTH and his co-workers, than attended those of FISCHER and ARMSTRONG, RYAN and others, all of whom had the potential components of the elusive sucrose at their disposal. Complex mixtures, apparently isomeridies of sucrose itself, always resulted. More success has now attended the efforts of our Swiss colleagues, PICTET and VOGEL who, working on much the same lines as their predecessors, sought to condense the tetra-acetate of *a*-glucose with the tetra-acetate of *g*-fructose in the presence of phosphoric anhydride. A complex mixture resulted, from which a well marked crystalline constituent was separated on solution in boiling alcohol and subsequent cooling. This product has proved to be identical with sucrose octa-acetate in melting point and in optical rotatory power. On hydrolysis, cautiously effected by means of sodium methylate, sucrose itself was obtained in measurable crystals. Naturally, in a matter of such importance, the identification of the synthetic sugar has to be very complete. PICTET and VOGEL'S product had the correct optical rotatory power both before and after inversion. The melting points of the modification crystallized from ethyl and from methyl alcohol were also the same as those of the natural product. Sweetness and other properties were in accordance with expectation. There seems no room for any other course than a whole-hearted acceptance of the synthesis and the congratulation of PICTET and VOGEL on their truly great achievement.—(*International Sugar Journal*, Vol. XXX, No. 360, p. 669.)

The Journal of the Central Bureau for Animal Husbandry and Dairying in India, Volume I, Part IV, contains an interesting note by the Indian Government Dairy Expert on the Murra Buffalo and its value as a dairy animal. Actual recorded yields are given, covering as many as 1,613 lactation periods, during which this breed of buffalo averaged 3,773 lb. of milk in a lactation period of 276 days in milk and 153 days dry. When it is remembered that the gestation period in the buffalo is 315 days, this record is excellent. The average fat content is 7 per cent.

NURSERY WORK.

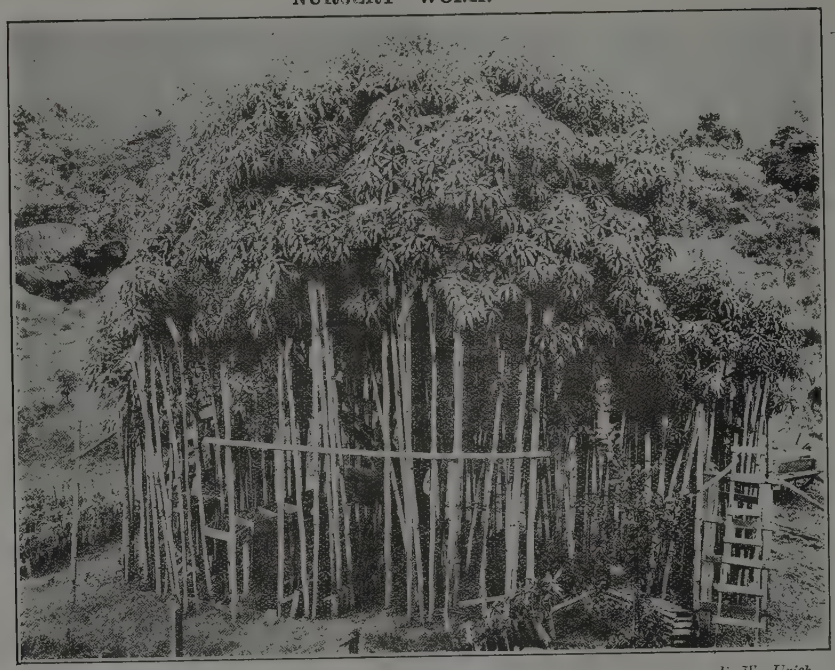
Photograph by *F. W. Urich.*

Navel Orange on Sour Stock, 4 years old—St. Augustine Experimental Station, Trinidad.

Photograph by *F. W. Urich.*

Parson Brown Orange on Sour Stock, 4 years old—St. Augustine Experimental Station,

NURSERY WORK.



Photograph by *F. W. Urich.*

Inarching Mangos.

Wardian case for long distance transport.

REVIEWS.

Animal Life of the Carlsbad Cavern. By Vernon Bailey. *The Williams and Wilkins Co., Baltimore*, 1928, pp. XIII+193. Price $3.00. London Agents, Bailliere Tindall & Cox, 8, Henrietta Street, Covent Garden, London, W.C.2.

This is number three of the Monographs of the American Society of Mammalogists. This will be found a very interesting account of the Carlsbad Cavern and of the surrounding desert country and of the plants and animals living in this environment. Situated in the Pecos River Valley in South-eastern New Mexico, the Carlsbad Cavern is the largest, most spectacular and best known of the numerous caves of the vicinity, containing enormous rooms (the largest is 450 feet wide and 250 feet high) and miles of vaulted highways. The descriptions of the desert plants, their adaptation to the life they lead and the beauty of their flowers when in bloom is very attractively presented and the account of the animals of the cavern and of the region are simply worded and very readable.

H. A. B.

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The Insects of Bermuda. By Lawrence Ogilvie, M.Sc. (Cantab.), M.A., B.Sc. (Abdn.) Department of Agriculture, Bermuda, 1928. 52 pp.

This little pamphlet prepared by Mr. Ogilvie, formerly Plant Pathologist, Bermuda, is called a Preliminary Checklist. This list is of considerable interest which is enhanced by the biological and economic notes which are added to the record of occurrence of several species. An instance is to be noted in the account of the biological control of the Oleander scale. Oleander hedges were a prominent feature of the island vegetation when, about 1920, this scale insect became destructively abundant and threatened the extinction of the oleanders throughout Bermuda. Attempts to control the scale insect cost the local Government over £4,000 in 1921 and 1922. In the years 1921-1924, parasitized scales on oleander twigs were obtained from Italy and, one species of parasite becoming established, a complete control was effected by 1927. An appendix contains a description of a new species of Aphis from Bermuda.

H. A. B.

* * *

Descriptive Economics. Lehfeldt. *Oxford University Press*. Price 2s. 6d., pp. 109.

This little book sets out to give "a plain account of facts, unmixed with theory" and throughout the writer succeeds in giving a most readable account of the chief occupation in their economic aspect. There are chapters on Farming, Mining, Manufacturing, Transport, Commerce, Finance, Government and Industry, and in each the illustrations chosen are not confined to temperate industrial conditions, and show a wide knowledge and experience of modern economic life.

G. W.

History of Economic Thought. L. H. Haney, Ph.D., *The Macmillan Co.* Price 15s., pp. 677.

This is already widely known and read. It aims at presenting a critical account of the contributions to economic thought of the leading writers of the western world. Such a task needs careful handling to prevent the work becoming a sort of dictionary. Mr. Haney first outlines economic thought before its development as a science, then deals with the building up of the science—the main section of the work—following this with a brief outline of leading schools of thought in recent years. In writing about individual economists, the pertinent circumstances of their environment are indicated, and their economic thought on value, distribution, &c. discussed. The work is valuable to anyone interested in economics and its development.

G. W.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books :—

BOTANY.

The Scientific Principles of Plant Protection. H. Martin, Edward Arnold, p. 316, 21s.

ECONOMICS.

Le Palmier à Huile. Institut Coloniale de Marseille, p. 306.

GENERAL.

Les Archives du Conseil de Flandre. Ligue Nationale pour l'Unité Belge. Anciens Etablissements d'Imprimerie, Th. Dewarichet, p. 552.

Acknowledgment.

We have also to acknowledge, with thanks, the valuable gift of the following books, presented by the Trustees of the British Museum :—

Monograph of the Lacertidae, G. A. Boulanger, 2 Vols.

Catalogue of the Chiroptera, Vol. I. Knud Anderson, p. 30.

First and Second Reports on Economic Zoology. F. V. Theobald.

Monograph of the Voles and Lemmings, Vol. I. M. A. C. Hinton, p. 488.

Catalogue of the Hispidae, Vol. I. J. S. Baly, p. 172.

Catalogue of Carnivorous, Pachydermatous and Endentate Mammalia, J. E. Gray, p. 398.

Catalogue of the Halticidae, Part I. H. Clark, p. 302.

Catalogue of the Ungulate Mammals, Vols. I-V. R. Lydekker and G. Blaine.

Catalogue of the Type Specimens of Lepidoptera Rhopalocera, Vols. I-III. N. D. Riley & A. G. Gabriel.

Insects of Samoa, Part VIII, H. G. Jackson, P. A. Buxton, A. Kastner and S. Hirst, p. 28.

Instructions for Collectors, 12. Worms, p. 24.

Report of the Temperature reached in Army Biscuits during baking with special reference to the destruction of the imported Flourmoth, *Ephestia Kühniella* Zeller. J. Hartley Durrant and Colonel W. W. O. Beveridge, p. 24.

COLLEGE NEWS.

Sir Algernon Aspinall, KT., C.M.G., C.B.E., Secretary of the Imperial College and Lady Aspinall, are expected to arrive in Trinidad by the s.s. *Asturias* on 31st January.

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The Principal and Mrs. Evans left on 27th December by the s.s. *Belize* for Tobago where they spent the Christmas vacation and returned on 10th January.

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Mr. H. A. Ballou, Professor of Zoology and Commissioner of Agriculture for the West Indies, sailed for Dominica and Antigua by the s.s. *Nova Scotia* on 29th December and returned by the s.s. *Dominica* on 14th January.

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Sir James Currie, K.B.E., C.M.G., has been made Chairman of a Directing Committee, recently appointed by the Right Hon. L. S. Amery, M.P., Secretary of State for Dominion Affairs and for the Colonies, to study every aspect of Mechanical Transport likely to further the economic development of the Oversea Empire.

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Our thanks are due to Mr. H. Hutton of St. Joseph, manager of "Moka Estate" for the gift of one hundred and fifty coffee plants, and to Mr. Connell of Verdant Vale for the gift of San Ramon coffee beans. Our thanks are also due to Mr. Taylor, Manager of Orange Grove Estate, for the loan of a tractor and plough.

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The following gentlemen have been elected members of the Governing Body:

Dr. Ambrose Thomas Stanton, M.D., F.R.C.P., Medical Adviser to the Colonial Office.

Mr. Frank Arthur Stockdale, C.B.E., M.A., F.L.S., who has recently been appointed to fill the new office of Assistant Agricultural Adviser to the Colonial Office.

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At a meeting of the Trinidad Science Club on the 20th December the Hon. C. Sadler, General Manager of the Trinidad Government Railways, delivered a lecture on "Problems of Railway transportation in Nigeria." Another meeting of the Club was held on the 10th January when Mr. S. A. Hammond, Director of Education, Jamaica, gave a lecture on "Rural Education."

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We are very greatly indebted to Mrs. Bovell, wife of the late Mr. John R. Bovell, I.S.O., F.C.S., for presenting the College with several boxes of pinned insects and of microscope slides, which formed part of her husband's collection, together with a meteorological chart and a valuable set of publications for the College Library. The donor's generosity has been much appreciated and we wish to thank her for these most useful gifts.

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Mr. F. W. Urich, Assistant Professor of Zoology and Entomology, and Mr. W. Cook, post-graduate student, sailed for Guanoco at the invitation of the Pitch Lake Company by the s.s. *Cataleya* on 28th December. The purpose of their visit was to investigate the cause of malaria which is prevalent in that settlement. They returned from Venezuela on 5th January and it is understood that they were successful in locating the breeding places of the mosquitoes.

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An official party from the s.s. *Lady Nelson*, the first of the new ships constructed by the Canadian National Steamship Company for the West Indian trade, visited the College on 1st January. The party was headed by Mr. Peter Jack and Mr. Gill Gardner and was accompanied by several influential members of the Trinidad Chamber of Commerce. In the absence of the Principal, they were conducted over the College by the Dean and Registrar. The members of the party individually expressed their surprise at the extent of the College activities and at the rapid progress that has been made.

Amongst other recent visitors to the College were Dr. Stahel, Director of Agriculture, Surinam, Mr. S. A. Hammond, Director of Education, Jamaica, M. René Gide of the N.V. Potash Export Company, Amsterdam, M. des Grottes (Martinique), Mr. Frank Agostini, Mr. Geoffrey Williams, Mr. B. C. Banks and Mr. S. M. Blair.

AGRICULTURAL EXCURSIONS.

THE seventh excursion of the term was made to Non Pareil Estate on Wednesday, 5th December. This estate, which is the property of Mr. E. A. Robinson, is situated in the heavy rainfall belt about four miles east of Sangre Grande and a similar distance from the east coast. It comprises about 2,000 acres, and although the main crop is cacao, considerable areas are also devoted to rubber and coconuts, whilst coffee is being increasingly cultivated. About 57,000 rubber trees are now being tapped, and the day was spent in examining the cultivation and production of this crop. The variety is all *Hevea braziliensis*, and most of the trees are from 15 to 20 years old. Apart from the methods of tapping, the system of planting was observed and the first attempts at budding from high yielding mother trees were shown by the Manager, Mr. Ferguson. Dr. Briton-Jones gave a field lecture on certain rubber diseases, including Brown Bast. Professor Hardy conducted the students through the factory, and discussed the technology of the coagulating and smoking processes. The party later on lunched at the Estate House with Mr. Robinson, who, in reference to an expression of thanks from the Principal, stated that he was very pleased to see the party from the College and was only too anxious to help in any way he could.

The eighth excursion took place on 12th December to Verdant Vale Estate, which is situated about half way up the Arima valley in the Northern Range. The object of this excursion was to study coffee in the field. Here again, this large estate, which is the property of Mr. Claude Connell,

is mainly devoted to cacao, but in recent years considerable areas have been planted up in coffee, and the area under nutmegs is also being extended. The tendency to increase the area under coffee in Trinidad has been marked in the last four or five years, following on the prohibition of imports of coffee into the colony as a precaution against the introduction of diseases and pests. So much is this the case, that after supplying the domestic demands of the Colony, it is expected that there will be an exportable surplus of over a million pounds this season.

The situation is an interesting one from the economic point of view, and the two great obstacles against an immediate large increase are, firstly the shortage of labour at the right time, and secondly the lack of drying space. These points were discussed most thoroughly. Diversity of cropping and better housing facilities were regarded as two possible solutions to the labour shortage, whilst the possibility of artificial drying needs investigation as a solution to the second point.

Mr. Connell personally conducted the party over part of the estate, and methods of pruning and the trials of new varieties were both observed. At present, practically all the coffee grown is 'Arabica,' and a good brand of berry is produced. Two different kinds of pulping machines were shown in action, and the vexed question of fermentation was discussed, connected as it is with that elusive character—flavour. A most enjoyable and instructive day was spent, and Mr. Connell was suitably thanked for his kindness in showing the party over his estates.

The ninth and last excursion of the Michaelmas Term took place on 19th December. The area visited was the Arena Forest Reserve, about 15 miles from the College and situated on poor lands from the agricultural point of view. The Principal, in a brief talk, pointed out the intimate connection that should, and in fact usually does, exist, between the Agricultural and Forestry Departments of the various colonies in the Tropics.

Captain R. C. Marshall, the Conservator, and Mr. R. Brooks, the Assistant Conservator, conducted the party round different blocks and were able to show forests in various stages of regeneration. The rates of growth of different species in different localities and on differing soils was most marked. The planting of seed *in situ* and of seedlings from the nurseries at stake was shown, some varieties responding to the first system and others to the nursery system.

The cost of regeneration was gone into in some detail, and under Trinidad conditions it was shown to be a rather expensive business in spite of its obvious necessity. The Forestry Department are carrying out experiments with a view to minimising costs by introducing saleable cover crops which, while bringing in some revenue, would at the same time provide the necessary shade for the young forest trees. Such crops as Cassava, Tannia and Pigeon pea, have proved fairly good in this direction. The most promising, however, is the banana, and the College are co-operating by growing about 30 acres of selected banana varieties in this way. These varieties are needed for the work on Banana Research that is being conducted at the College.

The excursion was well organised and reflects much credit on the officers of the Forestry Department, who were instrumental in providing the College party with an interesting and instructive visit.

G. E.

VISIT TO ST. VINCENT.

IN accordance with the practice of previous years, a party of seven post-graduate scholars of the Empire Cotton Growing Corporation, visited the Island of St. Vincent during the Christmas holidays. The party which was accompanied by Professor R. C. Wood and Captain J. McN. Wingate, took advantage of the Canadian National Steamship Company's new boats, travelling out in the *Lady Nelson* on the 1st and back in the *Lady Hawkins* on the 8th January, a great contrast to last year, when the return journey was made in a cargo steamer.

Mr. Jackson, as usual, proved an efficient organiser and in five days, the party were able to see a good deal of the island and its agriculture, as well as to visit the ginnery and cotton seed press, the Experiment Station, the Botanic Gardens, and Mr. Con. Hazell's dairy. Sunday was spent in an expedition up the Soufrière, and opportunity was taken on the return to see the coconuts at the Orange Hill Estate, and the up-to-date copra factory which Mr. Childs has established there.

The thanks of the party are due to all those who contributed to make the visit so successful and interesting.

R. C. W.

APPOINTMENTS.

The following appointments of students in residence at the College during the Session 1927-28 have been notified by the Secretary of State for the Colonies.

Mr. C. B. Taylor, Superintendent, Agricultural Department, Nigeria.

Mr. R. M. Maynard, B.SC., District Agricultural Officer, Tanganyika Territory.

Mr. W. Allan, B.SC., Assistant Research Officer, Northern Rhodesia.

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Colonial Appointments.

The following appointments and transfers have been made by the Secretary of State for the Colonies during the month of November:

Mr. R. H. Cowan, Produce Inspector, Agricultural Department, Nigeria.

Mr. E. S. Walker, B.A., Assistant Conservator of Forests, Federated Malay States.

Mr. H. A. Tempany, D.SC., F.I.C. (Director of Agriculture, Mauritius) Director of Agriculture, Malaya.

Mr. G. N. A. Hall (Veterinary Pathologist, Uganda) Veterinary Pathologist, Nigeria.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—The usual revision of sugar prices before Christmas was in buyers favour. Prices *c. i. f.* per cwt. have ranged as follows:

		Foreign	*Preferential*
		s. d.	*s. d.*
December,	4th ..	10 4½	14 1½
do.	6th ..	10 3	14 0
do.	11th ..	10 0	13 9
do.	12th ..	10 1½	13 10½
do.	31st ..	10 0	13 9
January	7th ..	9 9	13 6

The interest in new sugars is confined to parcels to fill gaps as the demand for refined is limited to actual requirements. In the United States the tone has been quiet and markets in the East have been stagnant. On the production side, Continental sugar factories have practically finished and Mr. Licht's December estimate is 8,097,000 tons as against 8,018,000 tons last December. The inclusion of 1,380,000 tons from Soviet territories is a disturbing factor but Mincing Lane by no means assumes that the total supply of beet sugar is increased. It is expected that the beginning of crop may hasten a decision of the Cuban Government as to its method of disposal.

* * *

COTTON.—The Liverpool Circular, 14th December, states that the cotton market continued quiet, quotations of most descriptions showing an advance, Mid-American stood at 10.71*d*. In the sakel market the chief feature was the considerable taking in of January hedges against Sudan cotton. The W. I. C. C. reports a small business in Sea Island at the following prices; fair, 23*d*.; fine, 27.50*d*.; and extra fine, 38*d*.

* * *

COCOA.—The cocoa market has been very quiet due to the holidays, and whilst it was hoped that prices would be maintained or even improved with the turn of the year, this has not materialised. If anything, prices are a little easier. (*By courtesy of the Cocoa Planters' Association, Trinidad.*)

* * *

COFFEE.—The weakness which was apparent in all coffee markets became pronounced in the first fortnight of December. The price of superior Santos which had remained steady for so many months at 100*s*. to 105*s*. at last showed a break from parity and on 10th December was quoted at 95*s*. per cwt. *c. i. f.* The bulk of East African offered attracted good competition from Home Trade buyers and in many instances extreme prices were paid for good Kenya coffee with size and satisfactory liquor. Good prices were made for better quality Tanganyika, the bulk of which was London cleaned.

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TEA.—In the middle of December tea stocks of 204,223,378 lb. showed that the 200,000,000 high-water mark of holdings was still maintained and in pre-war days the buyers' mastery of the situation would have been absolute. To-day this is by no means the case. Present sales give a mean of 16.58*d*., Ceylon making 21.47*d*., Indian 16.05*d*., Java 13.44*d*., Sumatra 15.69*d*., and Nyasaland 10.10*d*. Java and Sumatra did a large business, and some Sumatra fetched 17*d*. duty unpaid. The trade in China tea was slack, but 36*d*. was paid for Lapsang Souchong. Some Ceylon broken orange pekoe made 30*d*. and fannings of the same 28*d*. All really high quality tea was selling well.

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RUBBER.—After a firm period at the end of the first week in December the market became quiet and on 13th December prices were slightly lower. Sales were made of ribbed smoked sheet at 8-11/16*d*. to 8½*d*. Stocks both in the United Kingdom and the United States of America were at the lowest point, but this failed to cause any anxiety among buyers, as contracts for 1929 shipment from Malaya support the news of 50,000 tons having been added to the quantity on passage since the removal of restriction on 31st October.

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COPRA.—West Indian *f. m. s.* (11th Dec.) was lower at £25 10*s*. less ½ per cent. *c. i. f.* London or Rotterdam, December-January. Some low grade copra was offered as low as £24 5*s*.

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SPICES.—The market for *Pimento* has been very active and dearer. Business was done up to 111*s*. per cwt. *c. i. f.* Havre with options January shipment. *Ginger* was firmly held, but there was no improvement in the demand. Jamaica was quoted at 85*s*. to 130*s*. according to quality. Bold sizes of *Nutmegs* have been neglected but sound unassorted and wormy or broken were firm at 1*s*. 0½*d*. to 1*s*. 1*d*. and 8*d*. to 8½*d*. respectively. *Mace* has been quiet and about unchanged at:—red 3*s*. 4*d*.; palish to good pale, 3*s*. 5*d*. to 3*s*. 7*d*. per lb.—(*W. I. C. C.* 13th Dec.).

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LIME PRODUCTS.—*Lime Oil.* Handpressed continues very scarce. Nominal value is 60*s*. per lb. Distilled is dearer with business done for shipment at 30*s*. per lb. *c. i. f. Lime Juice.* Concentrated is firm without change in value (£25 12*s*. 6*d*. *c. i. f.*). Raw is steady but quiet with quotations unchanged.—(*W. I. C. C.* 13th Dec.).

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BANANAS.—There is a good demand for Jamaicas at £25 per ton (delivered) to wholesalers and 1*s*. per dozen (carriage extra) to retailers. Brazilians are unchanged at £20 per ton.